POWER

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Confiscation

IN TIMES of public peril or to carry out a foreign policy, even of aggression, which a government has decided to be for the public good, men may be uprooted from all their business and domestic relations and be mustered in and sent to the front for cannon fodder. It makes no difference how little sympathy they may have with the cause or how they regard the wisdom of the enterprise. They are subject to the call of their country, whatever the extent of the personal sacrifice involved.

A man has money that is needed by others and is making a good thing by lending it at such rates as the necessities of his victims enable him to extort; but the State steps in and, by its laws of usury, puts a limit on his little enterprise.

A landlord has put his wealth into real estate and, profiting by the abnormal conditions produced by the lack of housing accommodations, extorts from his tenants a rent that brings him a disproportionate return upon his investment. Again the State steps in and by its housing laws attempts to curb his rapacity.

An industry profits by the exploitation of the low-priced labor of children who ought to be at school preparing themselves for the duties of citizenship, and families eke out their slender means by permitting their younger members to be thus exploited; but the State, with a wider view, by its child labor laws, demands a chance for the boys and girls at the sacrifice of such exploitation.

The products of a great industry are declared to be detrimental to the well being of the people, and its producing establishments are shut down, the activities of its purveyors declared illegal, sources of great incomes peremptorily shut off and flourishing businesses rendered worthless, without compensation to their owners, because they are deemed to be inimical to the moral and physical development of the race.

I have no quarrel with these restrictions by the Government upon the liberty of the individual to do what he pleases with himself or what belongs to him. I wish that every act, individual or collective, could be motivated and regulated with regard to its effect upon the common well being.

But I am at a loss to square some of these regulations with the solicitude of those who make and interpret our laws for other forms of property rights and vested interests, which manipulation or a fortuitous development of circumstances has enabled their holders to exploit to just as obvious a violation of the public welfare.

A government that can make a law that would send an old woman to jail for giving a friend a bottle of home-made wine need have no compunction about making a law that would send men to prison for extortion through the control of national resources, processes of production or the avenues of distribution.

F. R. Low

European Development in High-Speed Hydraulic Turbines

By ELOV ENGLESSON
Chief Designer, Verkstaden, Kristinehamn, Sweden*

KAPLAN-TYPE turbines designed with movable blades to be adjusted for different load conditions, which improve the part load efficiencies. A 11,200-horsepower turbine of this type is being constructed to operate under 21.25 feet head and run at 62.5 revolutions per minute. Runner is 19 feet in diameter and weighs 62.5 tons.

SWEDEN, like certain parts of the United States and Canada, is a comparatively flat country, whose rivers contain large volumes of water with falls of no great height. It is therefore natural that high-speed hydraulic turbines should be of great interest to turbine manufacturers and owners of water powers in Sweden, and that the Kaplan turbine, which is of the high-speed type, should find good opportunities for being adopted in that country. The largest turbine works in northern Europe, Verkstaden, Kristinehamn, Sweden, were as early as 1913 considering the building of Kaplan turbines. Owing to the war, however, the project was discontinued until about two years ago.

This turbine, as is well known, is an axial type without a rim; in America it has been called a "propeller-type turbine." It is protected by a number of patents, of which two are of especial importance. According to the first, the blade width L, Fig. 2, shall be shorter than the blade pitch T; that is, L is less than T. By making the blades so narrow the friction is diminished, which makes it possible to drive this type of runner at

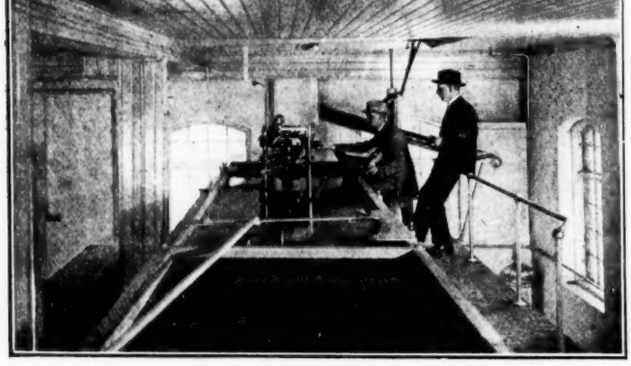


FIG. 1—TESTING TANK IN VERKSTADEN LABORATORY

a considerably higher speed, with the same head and output, than any other type, or in turbine language—a considerably higher specific speed is obtained. The other patent protects the principle that the blades can be turned in their sockets. The blades of the Kaplan turbine can be turned in the same way as the blades of a reversible propeller. Thus the guide vanes are not only adjusted so as to let less water through when the load is reduced, but the angle of the runner blades is also adjusted to suit the reduced quantity of water.

In America the larger turbine manufacturers have taken up the manufacture of propeller-type turbines with fixed blades and have made some very large units of this type for specific speeds up to about 150. When the manufacture of Kaplan turbines was taken up at Kristinehamn, it was soon found that with fixed blades these turbines gave results not satisfactory for the Swedish market, where high efficiency is of first impor-

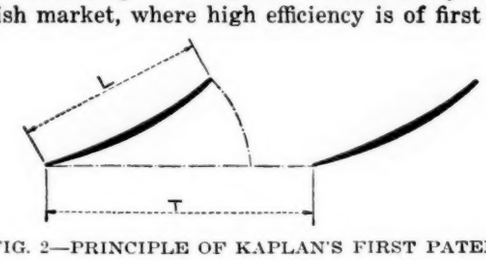


FIG. 2—PRINCIPLE OF KAPLAN'S FIRST PATENT

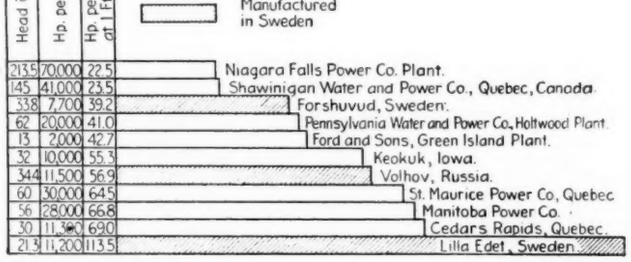

Head in Feet
Hp. per Unit
Hp. per Unit at 1 Ft. Head
Manufactured in America
Manufactured in Sweden
213.5 70,000 22.5 Niagara Falls Power Co. Plant.
145 41,000 23.5 Shawinigan Water and Power Co., Quebec, Canada.
33.8 7,700 39.2 Forshuvud, Sweden.
62 20,000 41.0 Pennsylvania Water and Power Co., Holtwood Plant.
13 2,000 42.7 Ford and Sons, Green Island Plant.
32 10,000 55.3 Keokuk, Iowa.
34.4 11,500 56.9 Volhov, Russia.
60 30,000 64.5 St. Maurice Power Co., Quebec.
56 28,000 66.8 Manitoba Power Co.
30 11,300 69.0 Cedars Rapids, Quebec.
21.3 11,200 113.5 Lilla Edet, Sweden.

FIG. 3—COMPARISON BETWEEN EUROPEAN AND AMERICAN VERTICAL TURBINES

tance. Turbines according to Kaplan's first patent reached a high efficiency, but only within a small range of load, which is in the neighborhood of full load, and the efficiency drops when the load is decreased at a rate that makes it not very satisfactory for a power station with a varying load and few units. To get over this difficulty, it was attempted to find a solution by designing a boss for the runner which should be strong enough to withstand the heavy stresses from the runner vanes when they are made movable. This problem has been solved so well that the Swedish government experts, after having examined the designs, recommended the purchase of a turbine with movable vanes, which is now being installed in the government's power station at Lilla Edet. This turbine will operate under a head of 21.25 ft. and will develop a maximum rating of 11,200 hp. at a speed of 62.5 r.p.m., which gives the runner a specific speed of 144 in the foot-pound system. In physical dimensions this unit will be larger than the largest turbine hitherto manufactured in the world.

The table, Fig. 3, shows in a graphic manner the

*Associated with Messrs. Boving & Co., Ltd., London, England.

output in horsepower of vertical turbines in the largest American and European installations all reduced to a head of 1 ft. From this comparison on the basis of a head of 1 ft. one gets an idea of the true dimensions of the turbine. This table shows how large the dimensions of the Lilla Edet turbines are as compared with existing turbines.

For the Lilla Edet installation a large number of tests have been carried out at Kristinehamn works.

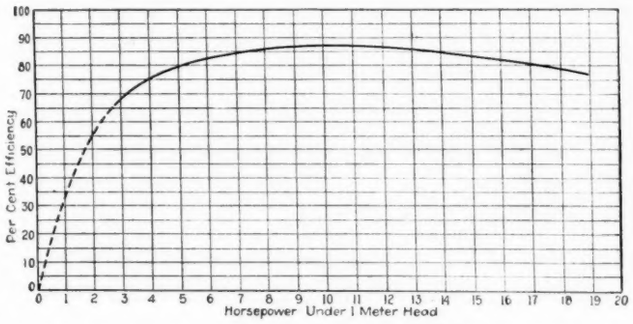


FIG. 4—EFFICIENCY CURVE OF 37.4-IN. TEST RUNNER FOR THE LILLA EDET PLANT

These tests have been made partly in the laboratory for the testing of draft tubes and turbine models, of a diameter of 11 in., and partly in the testing station for testing of larger models with a diameter of 26 in. The Water-Power Board of Sweden has built a testing station at Lilla Edet for the testing of runners with a diameter of 37.4 in. In this testing station a runner with draft tube and spiral scroll case of exactly the same proportions as those of the actual installation has been tested.

On account of the limited length permissible for the

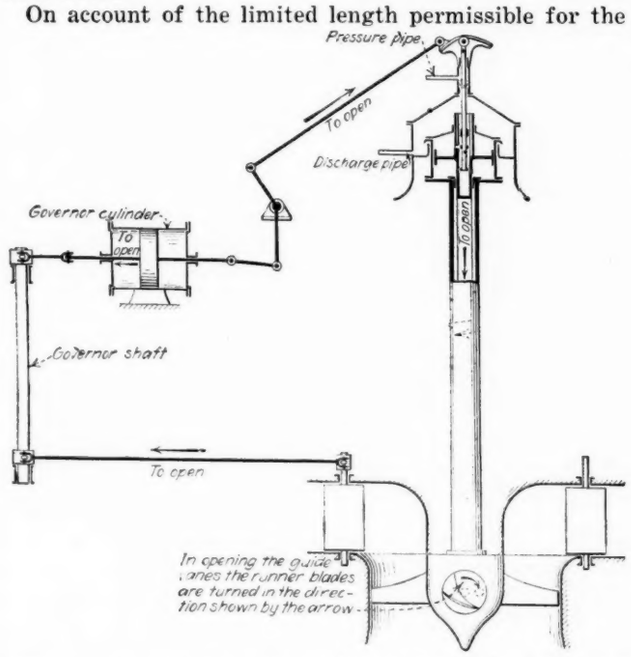


FIG. 5—DIAGRAM OF REGULATING MECHANISM FOR THE KAPLAN TURBINE

power station, the distance between centers of the turbines has had to be cut down to the lowest possible limit and thus there has been no opportunity of using a hydraucone or spreading draft tube which is rightly so popular in America. The distance between centers is only 49.2 ft.; that is to say, approximately 2½ times the diameter of the runner. For comparison it might be mentioned that the distance between centers at Cedar Rapids; Green Island, Henry Ford & Sons; and the Great Falls, Manitoba, installations are respectively 50, 52 and 57 ft., corresponding respectively to 3.34, 4 and 3.7 times the wheel diameter. The intake and

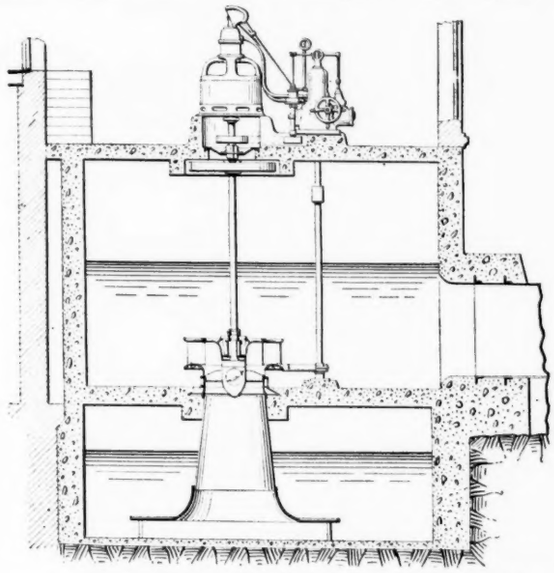


FIG. 6—SECTION THROUGH FORSVIK POWER PLANT

draft tube, therefore, are by no means the best possible, but the efficiency results with the model turbine are good, as can be seen from Fig. 4. This corresponds very well with the results obtained in the laboratory and testing station at Kristinehamn. The tests were made by the Water Power Board's engineers, and the water measurements were made by the screen method in a long inlet canal; the head for the test was about 13 feet.

The actual turbine will be about six times the size of this model, and since the efficiency increases with the size of the turbine, that obtained from the actual instal-

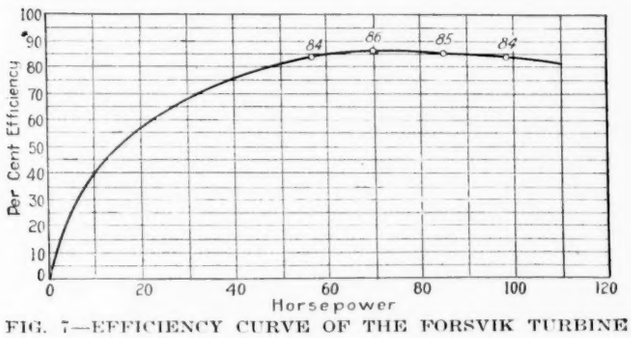


FIG. 7—EFFICIENCY CURVE OF THE FORSVIK TURBINE

lation will be high. The turbine's runner has a diameter of 19 ft. and weighs 62.5 tons. The boss in which the regulating mechanism is incorporated has a diameter of 7.8 ft., and the servo-motor for turning the four runner blades is placed in this boss. Its cylinder diameter is 5.3 ft., and the servo-motor can operate the blades with a force of about 345 tons with an oil pressure of 225 lb. The runner boss with its operating mechanism is filled with oil so that all parts are well lubricated. In order to prevent the oil leaking out of the boss, each blade flange is provided with a tightening device. This device in actual installations has already

proved satisfactory in operation. The turbine shaft is hollow, and the servo-motor is controlled through an operating rod which passes down the bore of the shaft. This rod is in turn operated by the governor. The method of governing is shown schematically in Fig. 5, but the servo-motor, as already mentioned, is placed in

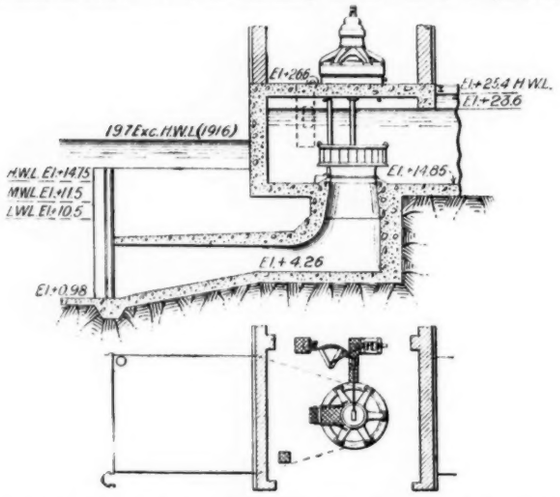


FIG. 8—SECTION AND PLAN OF THE POWER STATION AT STRÖMSBORG, SWEDEN

the boss and not on the upper end of the turbine shaft, as shown in the diagram. The movement of the runner blades is thus completely automatic under the control of the governor.

The governor and servo-motor are supplied with pressure oil from a special motor-driven oil pump, which is incorporated in the governor. In opposition to the usual practice in America of placing the servo-motors on the cover plate of the turbine to operate the guide vanes, in this case the servo-motor for the guide vanes is placed on the same floor as the generator.

The Lilla Edet turbine is now under erection. The Kristinehamn works, however, have built a number of Kaplan turbines of smaller dimensions which are already operating and have given satisfactory results. Such an installation is that of Forsviks, A. B., in central Sweden, a section through which is shown in Fig. 6. The turbine has an output of 100 hp. at 10.3 ft. net head at a speed of 300 r.p.m. and a specific speed of 162. Tests made in January of this year gave an efficiency curve in accordance with Fig. 7.

Another installation is that belonging to the town of Gevle at Strömsborg. A section and plan of this station is shown in Fig. 8. This turbine has the highest specific speed of any unit in the world. It was designed to develop 400 hp. under a 13.8-ft. head at 375 r.p.m. and was to produce at least 300 hp. with 11.2-ft. head, which occurs under flood conditions. According to the tests that have just been carried out by Prof. Hjalmar O. Dahl, of the Royal Technical High School, Stockholm, and Engineer A. Bjork, Gevle, it has been found that the turbine can be loaded to 536.3 hp. at its normal head and to 371.6 hp. at 11.2-ft. head without the efficiency suffering too much. The specific speeds at these loads are 218.5 and 235 respectively. At normal head the maximum efficiency reached was 88.2 per cent and the efficiency curve lies above 80 per cent between 190 and 465 hp. (see curves, Fig. 9). This installation is also of interest as it is run without continuous attention and is started and stopped from the main power station, which is some distance upstream. The draft tube is of Kaplan's original type of particularly simple shape, permitting easy placing of the forms for concreting.

In order to make a comparison between the test results from the Strömsborg turbine and those obtained from turbines with fixed runner vanes, there is shown in Fig. 10 the efficiency curves for test wheel 68-D6, as designed by a well-known American manufacturer and published in *Engineer and Engineering* of July, 1922, and a test curve of another American manufacturer's wheel (Holyoke test No. 2,543) according to information given by Forest Nagler in a paper read at the annual meeting of the American Society of Mechanical Engineers in December, 1919. These results are all plotted on the horsepower scale of the Strömsborg turbine; that is, each efficiency point is plotted against the horsepower on the Strömsborg turbine, which gives the same specific speed. Runners 68-D6 and 2,543 are smaller than the Strömsborg turbine, so that the highest efficiency does not come up to the same figure as

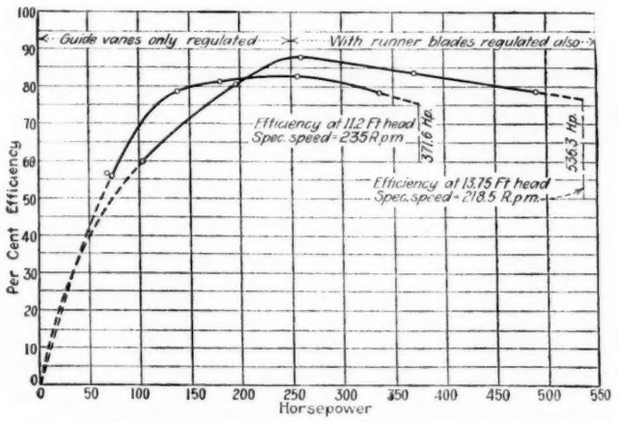


FIG. 9—EFFICIENCY CURVE OBTAINED AT THE OFFICIAL TEST OF TURBINE, STRÖMSBORG PLANT

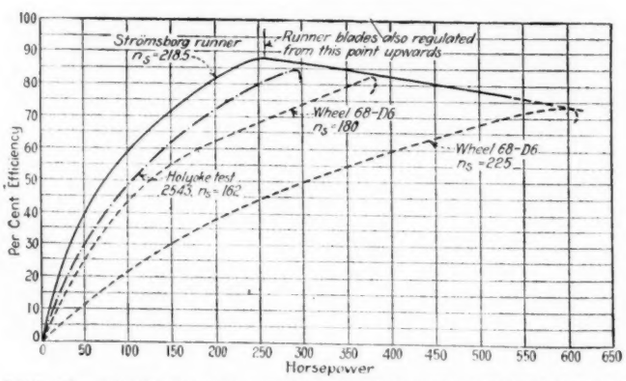


FIG. 10—COMPARISON OF THE EFFICIENCY FOR KAPLAN RUNNER WITH MOVABLE BLADES AND RUNNERS WITH FIXED BLADES

The Strömsborg runner was designed for a rated capacity of 400 hp., while the other runners are small test models. Therefore, the maximum efficiency of the latter does not come up to that of the larger runner. Below the point where the runner vanes are regulated, the efficiency curves are similar for all three runners.

the Strömsborg turbine, but on the other hand these wheels were tested with a spreading draft tube and with a straight conical draft tube respectively. It is interesting to see that the Kaplan efficiency curve below the point where the runner vanes are regulated, has the same shape as the efficiency curves for the other two turbines.

Material Thickness of Bumped Heads

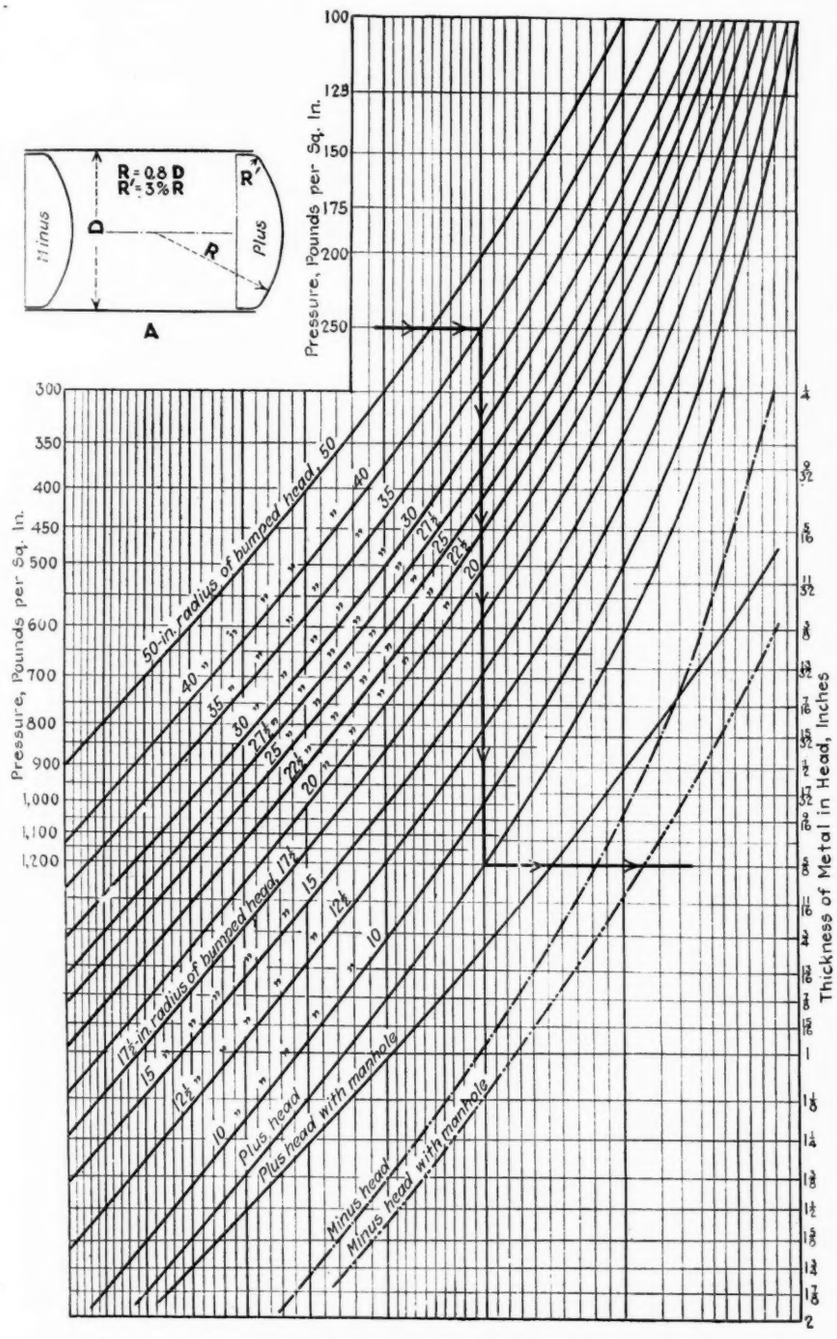
By Dwight Gerber

The chart displayed here is intended to serve as a ready means of graphically finding the proper metal thickness of either type of bumped head, with or without manhole, to be used in the construction of a pressure vessel having a diameter of 50 in. or less and over a wide range of pressures.

The meaning of the two terms, "plus" and "minus" heads will be quite obvious by considering that the "plus" head adds to the capacity of the vessel, while the "minus" head subtracts from it. These are illustrated at *A* in the Figure.

The amount of radius for the head on any diameter vessel has been fixed at eight-tenths its vessel diameter.

The internal pressure scale is arranged along diagonal lines connecting the upper and left-hand border, ranging from 100 to 1,200 lb. per sq.in. gage. The diagonal curved lines in the body of the chart are used to represent the value of head radius in terms of the diameter of the vessel. The approximately parallel lines marked for the various head types are base lines to be used in determining the thickness required for each.



BUMPED HEAD THICKNESS GRAPHICALLY OBTAINED FROM GAGE WORKING PRESSURE AND RADIUS

Compiled for heads with and without manhole, and based on constants determined by H. S. B. T. & I. Co.

Determining Thickness for a Given Condition

Example 1. Find the metal thickness in a bumped head for a vessel 40 in. in diameter carrying 250 lb. pressure per sq.in., the head to be of the "plus" type, without manhole.

This problem is outlined on the chart. Read horizontally to the right from the 250-lb. graduation in the upper left-hand scale, to the intersection with the curved lines marked 40 in. radius of bumped head. Go down along the vertical guide lines to the intersection with the base line marked "plus" head without manhole, and thence horizontally to the material thickness scale along lower and right-hand border. Read the thickness as $\frac{5}{8}$ inch.

By following the vertical guide lines down to the intersection with other base lines, the variation in the thickness of metal in bumped heads for different types may be determined for the problem stated.

By reversing the reading procedure, the allowable working pressure for any diameter can be determined for any particular metal thickness.

Example 2. A 30-in. diameter tank contains two minus heads of $\frac{3}{4}$-in. metal without manhole. What working pressure will the heads of standard dimensions stand?

Reading in the reverse order from example 1, we find the heads are good for 100 pounds.

The construction of the chart has been based on constants determined by the Hartford Steam Boiler Inspection and Insurance Company.

The layman who has the idea that everything in engineering is figured out with hair-splitting precision would be surprised if he knew how often 2 per cent is close working and 10 per cent is passable. At other times engineers must work to the tenth or one hundredth part of one per cent. Each case must be determined on its own merits and possibilities.

Chart for Determining the Strength of Used Elevator Cables*

By C. W. WILLETTS

IN THE issue of Sept. 18, beginning on page 451, an article, "Strength of Used Elevator Cables," gave the results of over 190 tests made on used cables and wires taken from these cables. The formula given in the following is based on the conclusions drawn from these tests and is intended for approximate results. A chart, Fig. 2, on the opposite page, has been worked out, which accomplishes the calculations that the formula is intended to perform.

Values and symbols used in the formula are:
Diameter of unworn wires, 0.041 of an inch.
Area of unworn wires, 0.00132 of a square inch.
Total number of wires in a 6 by 19 cable, 114.
Number of wires subject to wear, 72.
Number of internal wires, 42.
Cross-sectional area of 114 wires, 0.1504 square inch.

E = efficiency of construction and remains constant throughout the life of the cable. It is the ratio of the strength of the cable to the mean aggregate strength of its constituent wires.

S = Tensile strength of a worn 6 by 19 by ½-in. elevator cable.

S' = Tensile strength (pounds) of the same cable when new.

D = Smallest cross-sectional dimension (inches) of worn wires (see A on the chart).

N = Number of broken wires within a lineal distance of 6 inches.

A = Sum of the cross-sectional areas (square inches) of the 72 outside or worn wires.

$$S = E[\textit{Area of cable when new in square inches} - (\textit{area of wires broken within a length of 6 inches} + \textit{reduction of area by wear})] \times \textit{tensile strength of cable when new in lb. per sq.in.} \quad (1)$$

$$S = \frac{\textit{Original strength of cables (lb.)}}{E\,(\textit{area of cables (sq.in.) when new})} \times (\textit{present effective area of cable})E \quad (2)$$

All outer wires of the cable are subject to wear. Therefore, there would be $12 \times 6 = 72$ worn wires. The 42 inside wires do not wear. Substituting values and symbols in equations (1) or (2), they become:

$$S = \frac{S'}{E\,(114 \times 0.00132)}\,[(42 \times 0.00132 + A) - 0.00132\,N]E \quad (3)$$

The term $(0.00132\,N)$ is not exactly correct, since the broken wires are not full area. The error, however, is slight and is on the safe side.

By plotting the values of D against 72 times the respective cross-sectional areas A, the value of A in terms of D is: $A = \frac{D}{0.41}$ nearly. This equation checks within 0.0006 for all values of D under 0.039 in. (see Fig. 1). The full-line curve gives actual values of D, and the straight dotted line is the curve for equation $D = 0.41\,A$. Cancelling E and substituting the value of A in terms of D and multiplying the constants, equation (3) becomes

$$S = \frac{S'}{0.1504}\left(0.05544 + \frac{D}{0.41} - 0.00132\,N\right) \quad (4)$$

Equation (4) is necessarily an approximate formula, but it gives results that are fairly accurate and on the safe side, as indicated in Table I in the previous article.

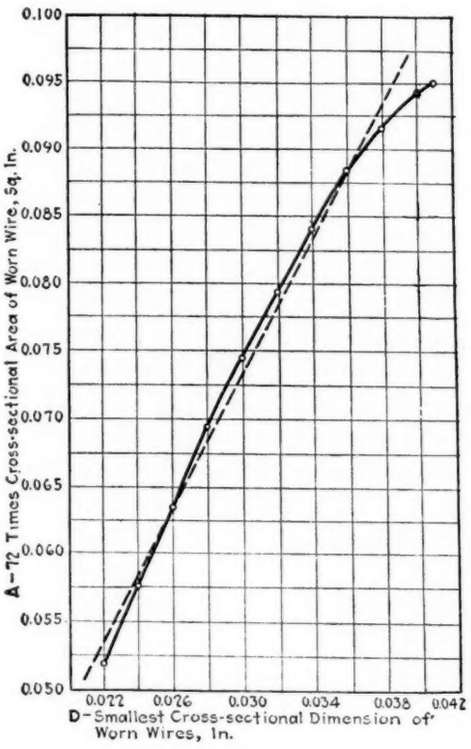
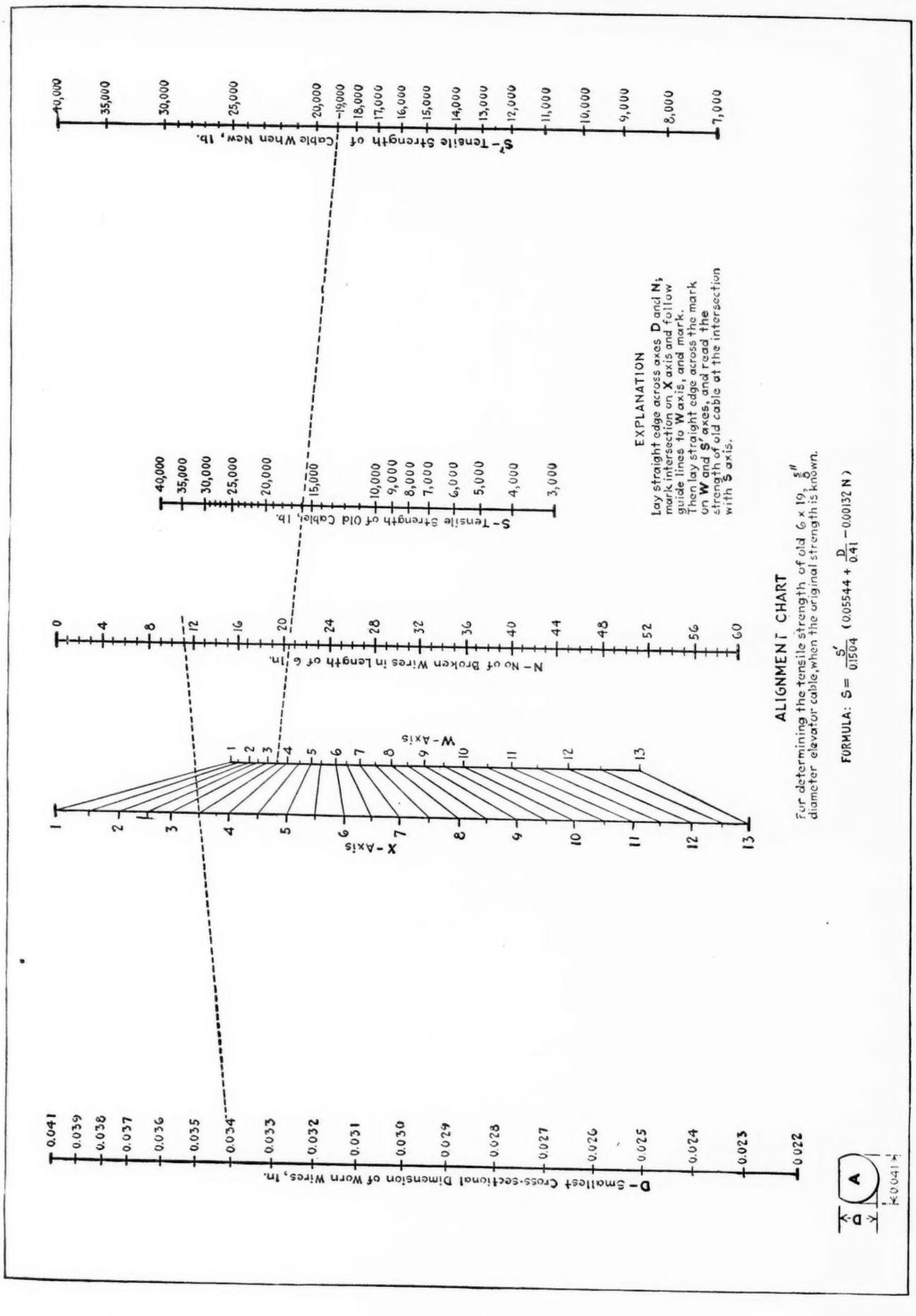


FIG. 1—RELATION BETWEEN SMALLEST CROSS-SECTIONAL DIMENSION OF WORN WIRE AND AREA OF OUTSIDE WORN WIRES ON A CABLE

The variables in the formula are readily obtainable quantities. The original strength can be found by a test of a specimen from the end of the cable before it is installed. If this is not possible, the book rating of the cable may be used. As a rule the book rating of any reliable make of cable is very nearly equal to its actual strength. The value of D is obtainable by measuring the wires with a micrometer. The value of N is obtained by counting the broken wires within a lineal distance of 6 inches. When several adjacent wires are broken, the wires should be raised to inspect the conditions of the inside wires. It would be a very unusual case to find inside wires broken.

To apply the formula, assume that the strength S' of the cable when new is 19,000 lb., that dimension D is

*The data in this article are from a thesis prepared by the author in part fulfillment of the requirements for the degree of mechanical engineer at the University of Cincinnati, 1923.


D – Smallest Cross-sectional Dimension of Worn Wires, In.
0.041
0.039
0.038
0.037
0.036
0.035
0.034
0.033
0.032
0.031
0.030
0.029
0.028
0.027
0.026
0.025
0.024
0.023
0.022
X – Axis
W – Axis
N – No. of Broken Wires in Length of 6 In.
S – Tensile Strength of Old Cable, Lb.
S' – Tensile Strength of Cable When New, Lb.
EXPLANATION
Lay straight edge across axes D and N; mark intersection on X axis and follow guide lines to W axis, and mark. Then lay straight edge across the mark on W and S' axes, and read the strength of old cable at the intersection with S axis.
ALIGNMENT CHART
For determining the tensile strength of old 6 x 19, 5/8" diameter elevator cable, when the original strength is known.
FORMULA: $S = \frac{S'}{01504}\ (0.05544 + \frac{D}{0.41} - 0.00132\,N)$

0.034 and the number N of broken wires in a distance of 6 in. is 11, then

$$S = \frac{19{,}000}{0.1504}\left(0.05544 + \frac{0.034}{0.41} - 0.00132 \times 11\right) = 15{,}646,$$

or approximately 16,000 lb. On the chart the problem is solved by laying a straight-edge from the value of D on the D axis, which is on the left hand, to the value of N on the N axis in the center of the chart. In this problem $D = 0.034$ and $N = 11$, therefore the straight-edge is laid from 0.034 on D axis to 11 on the N axis, as indicated by the upper dotted line. Mark on the X axis the intersection of the straight-edge, then follow along the guide lines from the mark to the W axis and mark again. Lay the straight-edge from this mark to the original strength of the cable value on the S' axis. In this case the value of S' is 19,000 lb., so that the straight-edge is laid from the mark on the W axis to 19,000 on the S' axis, as indicated by the lower dotted line. The tensile strength of the old cable is found on the S axis to be approximately 16,000 lb., as given by the formula.

The strength of the cable obtained in this way can be considered as applying to cables on the machine where they were originally installed. If an old cable is removed from an elevator and used for some other purpose, the new conditions may be such as to cause the cable to weaken very rapidly. Although the cable may, by test or calculation, show that it has a large percentage of its original strength when removed, two or three days' service under some other condition may cause failure under a load, equal to 10 per cent or less of the original strength of the cable.

If cables are not kept properly lubricated and become rusted, there is danger of wire failing inside the strands; in which case the formula would not show the true conditions of the cable. Where cables are kept properly lubricated, the possibilities of a wire breaking inside the strands is very remote. This statement is substantiated by the examinations made by C. B. Garrison, chief engineer of the Union Central Life Insurance Co. Bldg., Cincinnati, and the author of this article. We have taken apart a great many specimens of worn cables, but in no case has any broken inside wire been found inside the strands. However, in all cases the specimens were of worn cable that had been given good care while in service. So that, for such 6x19x$\frac{3}{4}$-in. worn elevator cable the formula and chart can be applied to obtaining the reserve strength with confidence of obtaining fairly correct results.

Preventing High Pressures in Refrigerating Plants

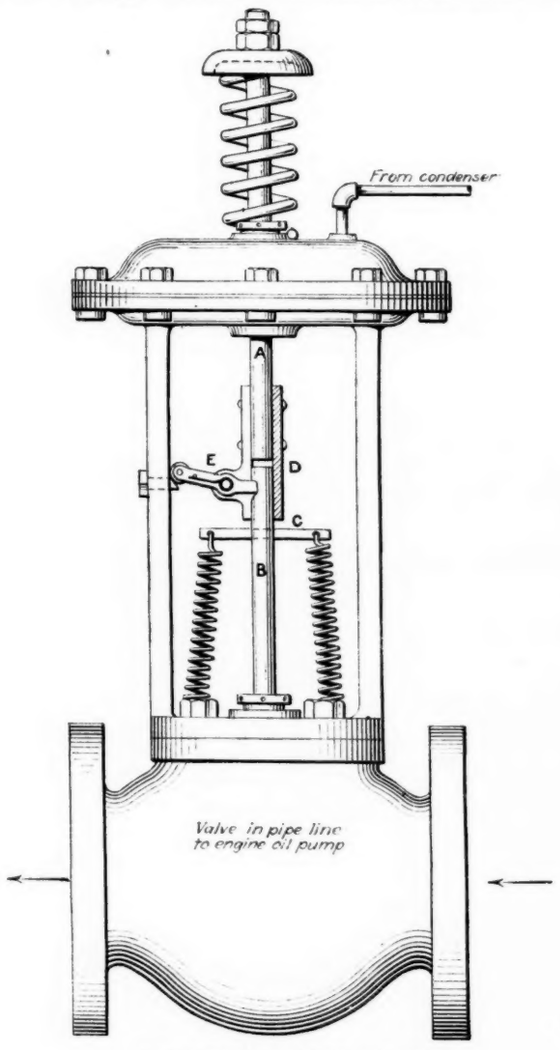
By J. Spugg

In oil-engine-driven ice plants the number of men employed is usually less than when steam machines are used. As a consequence the engineer must not only care for the engine-room equipment, but see that the condenser and other parts of the system are operating in a satisfactory manner.

If the condenser is placed on the roof, it is not always easy to see that the water is flowing over the coils in the right amount. Frequently, by reason of a failure in the pump or stoppage of the suction line, etc., the flow of water stops and the condenser pressure increases to an excessive value.

To prevent excessive pressure, the engineer of a plant where two 100-hp. semi-Diesel engines drive two ice machines, made two valves of the types shown in the illustration. The valve was placed on the pipe line leading from the oil tank to the engine fuel pump. If the condenser pressure increases above a predetermined value, the valve closes and the flow of oil to the pump is stopped, thus shutting down the engine.

These valves were originally diaphragm pressure-control valves. The valve stem A was cut so that the lower part B was left connected to the valve disk while the upper end A was held to the diaphragm in the case. A sleeve D having a lug on one side was made so that it slipped over B and was riveted to A. The



PRESSURE CUTOFF VALVE

lever E was fastened to the sleeve D and its inner end fitted into a groove cut in the end of B. The outer end of the lever had two rollers which moved along the standard as the diaphragm moved the stem. The lever E held A and B together and the valve disk was shifted with every movement of the diaphragm, but the opening through the valve seat was so large that a slight closure of the valve did not influence the oil flow to any extent. However, when the pressure forced the diaphragm down enough to cause the lever E to strike the lug, B was released from A and the spring immediately snapped the valve disk onto the seat.

In several instances of high condenser pressure the valves have shut down the engines.

Why Not Harness the Engine Exhaust?

THE value of the heat now wasted in the exhaust of internal-combustion engines is pointed out, and the types of waste-heat boilers in use and the installation costs are outlined.

BY L. H. MORRISON

THERE is a large amount of heat thrown away in an internal-combustion engine plant that might be recovered through suitable equipment and used in various ways. That more interest has not been shown in this problem of waste-heat recovery is due to the character of the plants using oil or gas engines, as well as to the tendency of engineers to be satisfied with the already high efficiency of this type of engine.

About 50 per cent of the oil engines used in this country are in central stations and in oil pipe-line pumping stations. Without investigation it might be concluded that there is no need for waste-heat recovery in these plants. On the contrary even in a central station there are ways and means of using this waste heat and the financial or other returns are of sufficient importance to justify a considerable expenditure in heat-recovery apparatus.

For example, the cooling water can be piped to bathing pools, and this has been done in several plants. Early examples of such systems are those at Appleton City, Wis., and at Palo Alto, California.

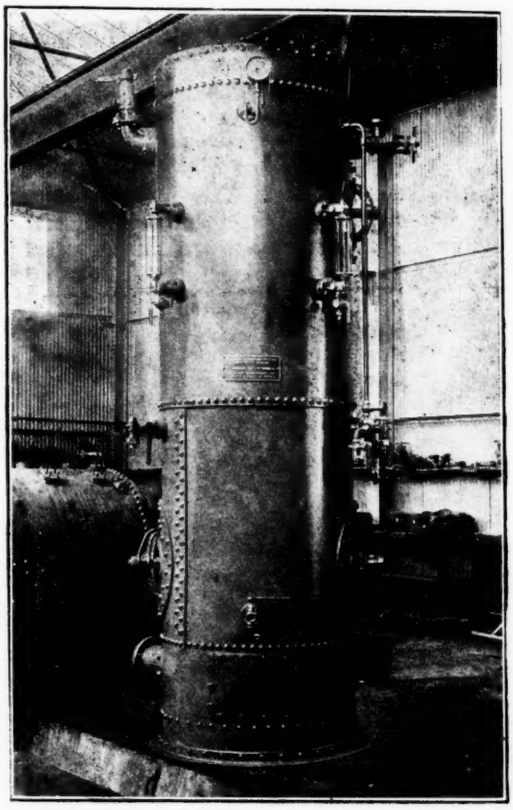


FIG. 1—WASTE-HEAT BOILER FOR A 1,250-HP. DIESEL

A number of central stations in the South and West are operated in conjunction with an ice plant. The raw-water ice system is used, and where the water is bad it has been found that unless the core is removed and replaced with distilled water the ice will be very dirty at the center. This grade of ice can be sold only where there is no competition. Consequently, a small steam boiler is used to supply steam for distillation. By installing a waste-heat boiler in the exhaust line, the fuel now used in the boiler is eliminated, at a considerable net saving.

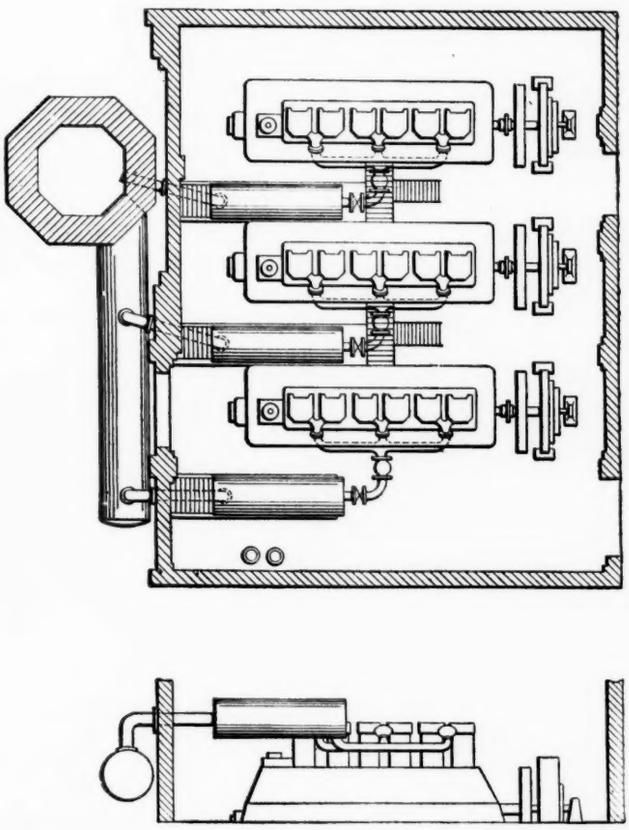


FIG. 2—INSTALLATION OF BOILERS IN AN ENGLISH OIL-ENGINE PLANT

Even in oil pipe-line work the waste heat may be put to good use. Most of such pumping stations are located at some distance from any town. It is usual to find that the station employees live adjacent to the plant, often in company-owned houses. Each plant has an office building of more or less extent. The heat in the cooling water could, with little expense, be piped to the several houses and offices and so replace coal-fired heating furnaces or stoves. In addition the greater part of the heat passing out of the engines in the exhaust gases could be used to raise the exit temperature of the cooling water to a higher temperature and so give a greater heating value to the system.

In many of these pumping stations, in cold weather the low temperature in the large storage tanks causes the oil to become so thick as well-nigh to prevent its being handled. In the Wyoming and other fields boilers are quite commonly used to supply steam to heating

coils in these tanks. These coils are placed around the suction line, and as the warmed oil is removed, the thicker flows in by gravity and is heated enough to permit pumping. It is quite easy to replace part if not all of the boiler plant by making use of the exhaust and cooling-water heat of the pumping plant. If the hot water is kept circulating continuously in the tank

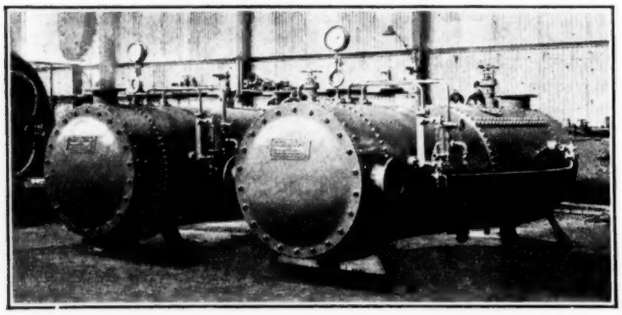


FIG. 3—HORIZONTAL-TYPE BOILER

coils, the tendency toward oil congealing would be eliminated and the net amount of heating largely reduced.

In flour mills where steam is used for wheat tempering and other purposes, the fuel now used in steam generation could be saved by waste-heat recovery.

In other industrial fields, when hot water or process steam seems to prohibit the use of oil engines, heat recovery may offer a solution.

Amount of Recoverable Heat

The question naturally arises, How can the exhaust heat be recovered, and what will be the total heat recovery in B.t.u. or in pounds of steam?

First, considering a gas engine of the usual efficiency of 13,000 B.t.u. per kw.-hr., or 10,000 per b.hp., some 40 per cent of the heat developed in the cylinder is discharged through the exhaust. Of this 4,000 B.t.u. per b.hp. a waste-heat boiler should recover at least 60 per cent. In other words, 2,400 B.t.u. may be recovered per brake horsepower. This recovery is based on a gas temperature of 900 deg. and an exit temperature of 360 to 375 deg. F. Since it requires 970 B.t.u. to generate a pound of steam from and at 212 deg., the exhaust gas will supply heat for 2.4 lb. of steam for each engine brake horsepower-hour with a feed-water temperature of 180 deg., which is quite possible by utilizing part of the jacket cooling water. The amount of steam could be increased by using an economizer to reduce further the gas exhaust temperature.

Assuming an evaporation of 7 lb. of water per pound of coal, each engine horsepower will supply steam equivalent to over 0.33 lb. of coal per hour.

In case of the Diesel engine the thermal efficiency is such that only about 8,000 B.t.u. per b.hp.-hr. is used, of which some 35 per cent passes out the exhaust line. The exhaust temperature is low, around 700 deg. F., and if the same exit temperature, 360 deg., be used, the recovery becomes $1 - \frac{T_e - 60}{T_i - 60}$ where T_e is the stack temperature in degrees Fahrenheit and T_i the engine exhaust temperature, or $1 - \frac{360 - 60}{700 - 60}$, which is about 50 per cent. In other words, 1,400 B.t.u. per b.hp.-hr. may be recovered, equivalent to approximately 1.4 lb. of steam or slightly under 0.2 lb. of coal.

The exit temperature of 360 is based on having the steam pressure at 100 lb. gage, which would give a difference of 44 deg. between the steam and the gas discharge temperatures. If low-pressure steam is needed, say at 5 lb. gage, the gas temperature can be reduced to 300 deg., making the percentage of heat recovery slightly larger.

The recovery of the exhaust heat by steam generation is then of little consequence in plants of much under 300 hp. A plant of this size would supply 10,000 lb. of steam a day and by so doing save over half a ton of coal a day.

A plant of 1,000 hp. would show a yearly saving of 864 tons, which, with coal costing $7 a ton in the boiler furnace, represents a saving of $6,000 a year. Since the waste-heat boiler can be purchased somewhat below the price of a coal-fired boiler, the actual saving is greater than that given. In view of the fact that there are many plants of over 1,000 hp. the possibilities should be of interest.

It has been found that the amount of recoverable heat in the exhaust is almost in proportion to the mean effective pressure of the engine and to the boiler output. At an m.e.p. below 40 lb. per sq.in. the exhaust temperature is so low that the recoverable heat just about offsets the boiler radiation losses.

Savings in Large Plants

The numerous large gas-engine installations of from 5,000 to 75,000 hp. are a most attractive field for such recovery systems. For example, consider a steel-works gas-engine plant of 25,000 hp. The generation by the waste heat of 62,500 lb. of steam an hour would mean a net saving of 35,000 tons of coal a year. Such boilers could be installed for about $5 per engine horsepower.

Where hot water and not steam is required, such as in building heating, washing treatment in silk mills, etc., the heat recovery becomes much greater. Taking

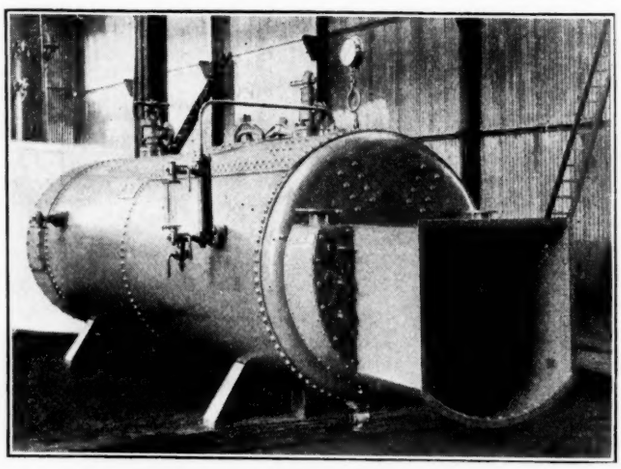


FIG. 4—BOILER WITH COMPARTMENT FOR GAS BURNING

the Diesel plant as the basis of computations, about 30 per cent of the heat of the fuel is absorbed by the cooling water. The jacket discharge temperature can be carried at, say, 155 deg. F., which, with an entrance temperature of 100 deg. F., would call for 44 lb. of water per brake horsepower-hour. The exhaust-heat boiler could add around 1,400 B.t.u. per engine horsepower which would raise the 41 lb. of water from 155 to 187 deg. F. The total recovery of heat is therefore

3,800 B.t.u. per b.hp.-hr., equivalent to about one-half pound of coal. In case of a 500-hp. engine the saving would be 3 tons of coal a day, or over $7,000 a year.

While a number of waste-heat boilers have been built in this country, broadly speaking, the subject has been ignored by boiler manufacturers and engine users. The navy installed two such boilers of the water-tube type on the battleship "Maryland," in connection with two 900-hp. Diesels. While the efficiency obtained has not been published, no doubt it is low by reason of the water-tube design. Since little if any radiant heat exists in the gases, the fire-tube design, which offers a long gas travel and high gas velocities, is no doubt the better design. Likewise a few cast-iron heaters are in use in small plants.

Modern Boiler Designs

In England there are over 200 plants making use of waste-heat boilers, most being of the type illustrated in Fig. 1, which shows a vertical boiler used in connection with a 1,250-hp. Diesel. Horizontal boilers are, however, equally adaptable and are being built along the lines of Fig. 3; Fig. 2 is a plan of an English oil-engine plant where each engine is fitted with this type.

The Spencer-Bonecourt, Ltd., has developed this boiler to include a compartment wherein gas may be burned by combustion in the long fire tubes in case the engine output is insufficient, as shown in Fig. 4. The same idea is carried out in a boiler where oil is burned in a small furnace in front of the tube bank.

The boilers illustrated are developments of the Bonecourt boiler, originally built as a steam boiler to use coal gas as fuel. The designers, Prof. W. A. Bone and Lieut. C. D. McCourt, were able to obtain a thermal efficiency of 92 per cent and over. The tubes were filled with broken firebrick, and a mixture of gas and air was forced through this material under a draft of 20 in. Combustion without excess air was thus obtained. From this original design a boiler was developed in which the tube-packing material was eliminated and the draft reduced, while still maintaining a high efficiency. For waste-heat recovery each tube is filled with a retarder in the form of a special steel ribbon quite like a screw conveyor.

The question of corrosion due to sulphur in the fuel is often raised. Experience with existing installations indicate that no danger exists. The only precaution necessary is to see that the tube-cover doors are opened about once a month to inspect the tube ends for weeping. If tube leaking goes on without correction, in time the water may cause corrosions.

In all installations the boiler should be placed as close to the engine as possible to eliminate as much as possible the loss of heat by radiation.

The method of connecting the flexible cable of the shunt or pigtail to the brush on electrical machines is of the greatest importance. In the first place, the connection should be of low electrical resistance. As an aid to this characteristic it should have as large an area of contact as possible and the contact should be firm at all points. The use of solder is of considerable advantage in securing low resistance, but care should be taken in the construction of the connection so that there are no pockets where an excess of solder can gather to drop out on the commutator or cause the brush to stick in the holder should a temperature be encountered sufficient to cause the solder to melt.

Principles of Operation of the Polyphase Induction Motor

By Gordon Fox*

The action of the polyphase induction motor is usually explained on the basis of the revolving-field theory. This explanation is justly popular, but it fails to bring out the close resemblance in fundamental theory between the induction motor and the direct-current shunt motor. The following explanation is presented for the purpose of developing that resemblance.

Figs. 1 and 2 show the primary form of a two pole two-phase induction motor. In theory and performance it duplicates closely the familiar squirrel-cage motor. In the squirrel-cage type the rotor currents are free to distribute themselves along a plurality of paths which

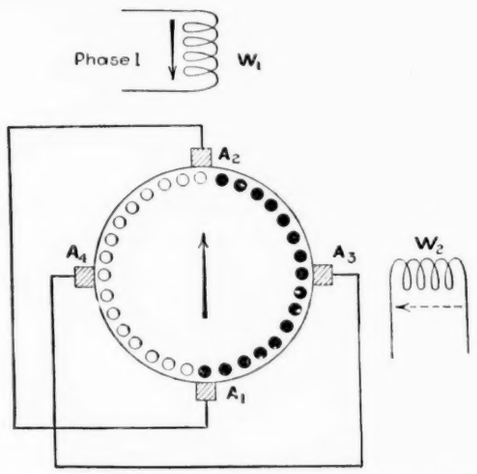


FIG. 1—SCHEMATIC DIAGRAM OF TWO-POLE TWO-PHASE INDUCTION MOTOR

Solid arrows show magnetizing forces due to load current. Dotted arrows show magnetizing forces due to magnetizing current.

revolve with the rotor. In the commutator equivalent the paths for the rotor currents are fixed in space by means of brushes that are independent of rotor movement.

In the motor shown in Figs. 1 and 2 there are two primary or inducing windings displaced 90 deg. Winding W_1 is connected to phase 1 and winding W_2 is connected to phase 2 of a two-phase supply. The rotor is similar to the armature of a direct-current motor. It is provided with two sets of brushes A_1, A_2 and A_3, A_4 which short-circuit the rotor in line with the axes of the stator windings. The voltages in the primary or stator windings W_1 and W_2 cause magnetizing currents to flow in these windings, setting up two fluxes which differ in time phase with each other by 90 deg. owing to the fact that the supply voltages have a 90-deg. relation. The alternating flux set up by W_1 induces a voltage in the rotor coils, by transformer action. This voltage appears at brushes A_1 and A_2. Since these brushes are short-circuited, a current flows through the rotor conductors and brush short-circuit as indicated by the dots and circles in Fig. 1. The dots represent current flowing in one direction and the circles, current flowing in an opposite direction. The induced voltage is 90 deg. out of phase with the flux which induces it, namely, the flux due to W_1. In normal operation the current due

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*Electrical Engineer, Freyn Brassert & Co., Chicago.

to this voltage is practically in phase with it. Therefore, this current is in phase with the flux due to W_2 and reacts with it to create a torque, just as the armature current in a direct-current motor reacts with the field flux to produce torque.

The resistance of the rotor and of its external short-circuit is low as related to the voltage induced in it. If only the resistance and reactance of the rotor were available to restrict the current flow, a heavy current would result. The rotor conductors, rotating in the flux due to W_2, have generated in them a voltage, which is in time phase with the flux due to W_2 and opposite to the induced voltage due to W_1. This generated voltage thus corresponds to the countervoltage generated in the conductors of a direct-current armature.

If the rotor of this motor were to revolve at synchronous speed, the countervoltage generated along the axis of W_1 and W_2 would equal the induced voltage along

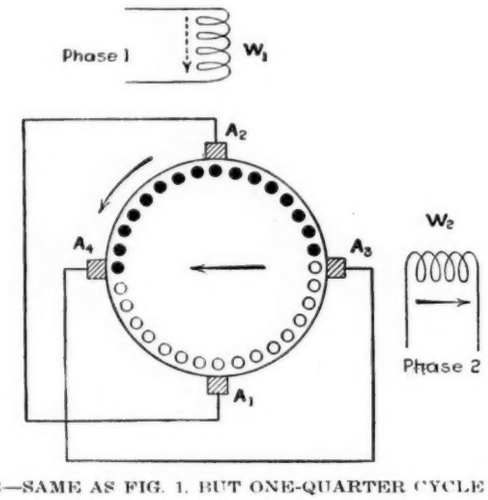


FIG. 2—SAME AS FIG. 1, BUT ONE-QUARTER CYCLE LATER

the same axis, hence no current would flow and no torque would be produced. This condition would be identical with that obtaining in a direct-current motor running slightly above its no-load speed when the countervoltage would equal the impressed armature voltage.

The polyphase induction motor is identical in fundamental theory with the direct-current shunt motor with the difference that the current is conveyed to the rotor inductively instead of conductively and with the further difference that reactance plays a part in the induction, but not in the direct-current machine.

The magnetizing force due to the induced load current in the rotor Fig. 1 is along the vertical axis. The induced rotor current is in normal operation, practically in phase with the induced rotor voltage which is in opposition to the primary voltage W_1; therefore the rotor current tends to demagnetize the stator. This causes the stator winding W_1 to draw current from the line in time phase with the supply voltage, sufficient to neutralize the demagnetizing influence of the load current in the rotor. Thus the load demand is reflected to the supply system and load current is drawn from the line. The relations between magnetizing current and primary and secondary load current in this motor are identical with those in the static transformer.

Only the action with reference to the brushes A_1 and A_2 were considered in the foregoing. In a similar manner winding W_2 induces in the rotor conductors a voltage and current indicated by the dots and circles in Fig. 2. This current reacts with the flux due to W_1 to produce torque. The rotor revolving in the flux due to W_1 generates a countervoltage appearing at brushes A_3 and A_4, so that the action duplicates that previously described.

It will be seen that this two-pole motor has two working axes, one for each phase. This compares with the single working axis per pair of poles of the direct-current motor. As the material is utilized along two axes per pair of poles in the two-phase induction motor, it is used to better advantage than in a direct-current motor. This is the main reason why a polyphase motor can be made lighter than a direct-current motor for the same output and speed.

In normal operation the rotating member of the motor illustrated in Figs. 1 and 2 is revolving at nearly synchronous speed, the rotor impedance is low and the currents flowing in the rotor conductors are practically in phase with the voltage that produces them. These currents are then practically in phase with the fluxes with which they react to produce torque, and the operating torque per ampere is high. When the rotor is at rest, the rotor currents lag considerably behind their respective voltages. For this reason the ampere-turns in one rotor axis are not in phase with the flux in the other rotor axis and the starting torque per ampere is low. In this respect the polyphase induction motor differs distinctly with the direct-current shunt-wound motor.

The primary form of the two-phase motor just described is not in commercial use because of the far greater simplicity of the equivalent squirrel-cage motor, but as previously stated, the squirrel-cage motor parallels closely the primary form in theory and performance.

Installing Oil Tanks

In installing fuel-oil storage tanks inside a building, the location should be such that the tank is below the lowest story, or basement. The piping should be placed in such a way that the oil will drain back to the tank. In no case should the arrangement be such that siphoning of the tank can occur.

Tanks should be set on a firm foundation supported independently of the floor construction and completely inclosed with a heat insulation of reinforced concrete not less than 12 in. in thickness (8 in. for concrete tanks) with at least a 6-in. space between the tank and the concrete insulation, filled with sand; for concrete tanks, a top insulation of 12 in. of sand without concrete covering is sufficient.

The walls of tanks, including those for insulating purposes, should be constructed independently of and not in contact with the building walls. The insurance companies accept 8 in. of concrete and 6 in. of sand as insulation for metal tanks when located in a fire-resistive oil room or special oil-storage building. The space occupied by the sand insulation must be drained through the insulating concrete wall by means of a pipe not greater than 2 in. in diameter.

"Can smoke be prevented?" Yes, it can to the point where it will do little harm, but entirely, not, for many, many years to come. A careless man will cause smoke even when the equipment is the best, but if the equipment is good and the man properly instructed, there will be no smoke. From an article by V. J. Azbe in *Forge*.

Edge Moor Single-Pass Boiler

A new type of water-tube boiler embodying some distinct and important features is now being produced by the Edge Moor Iron Co., Edge Moor, Delaware.

The boiler is somewhat different in character from anything heretofore developed, some of the outstanding features being its single-pass construction, the absence of the customary baffles, provision for controlling the steam temperature, and large amount of tube surface exposed to the radiant heat of the furnace.

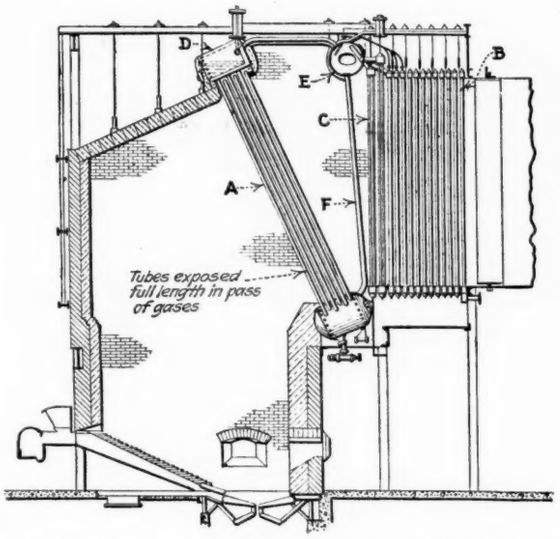


FIG. 1—SECTION THROUGH BOILER SETTING AND FURNACE, SHOWING ARRANGEMENT OF THE HEATING, STEAMING AND SUPERHEATING PORTIONS

Referring to Fig. 1, which shows a sectional elevation through the boiler setting and furnace, equipped with an underfeed stoker, it will be seen that the boiler consists essentially of three parts, the steaming section *A*, the heating section *B* and the superheating section *C*. The steaming section and the heating section are directly connected together and constitute the boiler as a whole. A plan and horizontal section is shown in Fig. 2.

The steaming portion is composed of a series of sections constructed with a cylindrical drum or header at the top and bottom and connected by a bank of tubes. The upper header of each section is connected by three circulators, or steam tubes, to a main crossdrum *E*, which in turn is connected through a row of circulators *F* to the lower header. Thus in the steaming portion of the boiler the water moves rapidly in a closed circuit independent of the heating section.

Referring to Fig. 2, it will be seen that the design of the heating portion is such that the gas pass contracts in sectional area from the furnace to the flue. In this way compensation is made for the temperature drop and the resulting changes in the volume of the gases, tending to maintain a uniformly high rate of gas travel.

The superheater, which is built with straight tubes assembled in forged steel headers, is located close to the heating section, as seen in Fig. 1. The superheater, like the other portion of the boiler, is suspended from overhead structural steel girders. This method of suspension leaves the boiler practically free from expansion strains.

An important feature is the provision made for controlling the temperature of the steam. This is accomplished by assembling the superheater tubes in groups with dampers in the spaces between the groups. By regulating these dampers, the flow of gases across the tubes is controlled. The dampers are operated by an electric motor under thermostatic control. This makes possible the maintaining of a practically constant steam temperature under a wide range of performance.

A power-operated soot-blowing system is built directly into the boiler. These blowers are stationary elements with nozzles arranged for the most effective cleaning. The elements are arranged in groups with internal piping connections. The steam lines to the blowers lead from an assembly of cam-operated valves actuated by an electric motor. A switch on the motor circuit may be operated by hand, or a clock control may be applied for blowing regularly at any desired interval. The omission of the usual external steam piping and valves to the soot blowers leaves the side walls clear and adds much to the external appearance of the boiler. With this type of construction a separate economizer is not required, as the heating section of the boiler is proportioned to meet the desired conditions. The boiler is inclosed for the greater portion with a sectional air-tight casing, brickwork being employed only for the furnace.

The sectional construction provides a flexible arrangement and permits the boiler being assembled for vertical gas pass with flue outlet at the top, also as a double boiler with vertical gas pass and double-ended furnace, or the double boiler can be provided with two single-ended furnaces. In this manner a boiler of large capacity can be obtained in one unit.

It is claimed by the manufacturers that the draft loss is less than half that usually encountered for equal capacity and efficiency and that the boiler responds readily to high rates of evaporation without the usual rapid falling off in efficiency. The best efficiency is obtained when the boiler is evaporating at the rate of about 9 lb. of water per hour per square foot of surface, or in other words at 300 per cent of rating. At 400 per cent of rating the results are about equal to those heretofore obtainable around 165 per cent of rating.

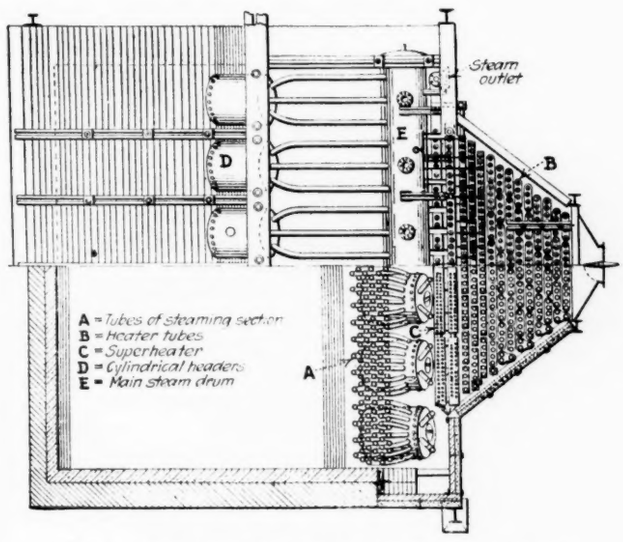


FIG. 2—SECTION AND PLAN VIEW OF BOILER

Governing Devices of Westinghouse Geared Turbine Units

A previous article described valve gears on small direct-connected turbines for generators and also for auxiliary drives. Geared units, however, are equipped more elaborately, utilizing a vertical slow-speed governor, with special arrangements for automatic lubrication.

GEARED turbine sets, Fig. 1, utilize a direct-driven gear with a vertical governor, details of which are shown in Fig. 2 at *A*.

A compression-type governor spring is also employed in this case, as well as the usual flyball governor construction. The flyball weights (34) are made of steel cylinders to which is riveted a thin flat steel plate, acting as a lever. These weights pivot on knife-edges (33) carried in holders riveted to the governor arms. Centrifugal force causes these weights to fly out so that knife-edge (20) at the other end of the arm rises against the force of the compression spring (29). This spring rests on yoke (83) through which the governor spindle passes with considerable clearance. This yoke is connected to the governor clutch sleeve by means of

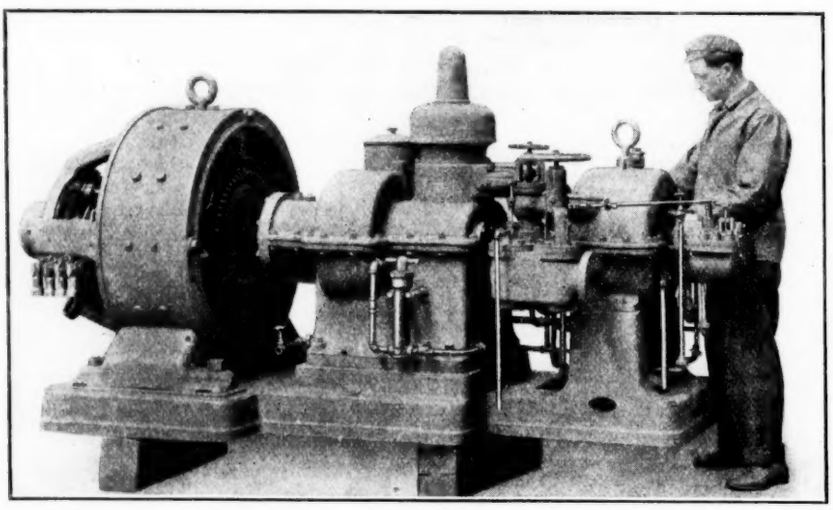


FIG. 1—SLOW-SPEED VERTICAL GOVERNOR DIRECTLY CONNECTED TO BALANCED POPPET VALVE

two posts. The governor itself is carried in a bracket or yoke. The movement of the flyballs therefore tends to lift up the clutch sleeve when the turbine speeds up. This movement is transmitted through levers to the poppet valve.

The governor itself is supported by a bracket or yoke (16) which is bolted to the gear base. A long bronze bushing (28) is pressed into this bracket and reamed out to make a fit for the governor spindle, throughout a short distance on each end as a bearing. It will be noted that the governor clutch sleeve slides up and down on the upper portion of bushing about which it rotates. The object of the design was to reduce the friction between the clutch sleeve and the guide on which it slides. This is very well effected by arranging for the one to rotate around the other, so as to avoid the friction of starting. In other words, the clutch is constantly rotating about the guide so that any tendency to lift or lower the clutch is not subject to the sticking that ordinarily occurs where two bodies in contact are at rest with each other, and one of them is moved.

The governor clutch sleeve, Fig. 2 at *A*, refers to the sleeve which is moved up and down by the governor, and rotates at the same speed as the governor. Another element, which is called the governor clutch, does not rotate, but is moved up and down by the movement of the revolving clutch sleeve. The governor clutch is carried in a recess in the clutch sleeve, the lower rubbing face of this recess being the upper face of the nut on bottom of the clutch sleeve. This nut is locked by a lockscrew. A minimum clearance is allowed on the rubbing face of the clutch. Quite a large clearance, however, is provided between the hole in the clutch and the corresponding diameter of the clutch sleeve which is contained inside. This allows considerable radial movement. The governor lever is connected to the clutch by means of two pins, one shown at (25), which fit in recesses on opposite sides of the clutch.

Most of the Westinghouse turbines, up to 500 kw. are built with direct-connected valve gears, in which no form of oil relay is provided, but where the governor moves the valve by means of its own force.

It will be noted that the vertical movement of the clutch sleeve is limited. To begin with, in the low-speed position the governor arm (34), Fig. 2 at *A*, will be pushed down by the spring until the point of (44) contacts with the governor arm. This stops further movement. The clutch sleeve will then be in its lower position. Secondly, the vertical upward movement of the clutch sleeve is limited by the stop collar (35).

The instruction book will give the proper distance that the valve should move from the low-speed, or wide-open, position to the closed position. With the machine shut down one of the links such as the pin in the joint at (72), Fig. 2 at *B*, may be removed and the valve then shut. The distance that is necessary to move from the pin position to the shut position should not exceed that given in the instruction book.

A more positive way of adjusting the valve, when no instruction book is convenient, is to remove the governor spring entirely and pull out the flyballs until the valve is closed and then adjust the linkage so that there will be at least $\frac{1}{8}$ in. or preferably $\frac{1}{4}$ in. between the governor clutch sleeve at the top, and the stop on the governor. Care must be taken to see that the knife-edges do not get out of place while the governor spring is off. Before doing this, the position of the speed-adjusting nut (30) should be carefully measured so

that, after putting it in place, it can be brought up to the proper position.

The real point is that the governor valve must be forced to its seat by the governor while there still remains some reserve travel in the governor. This of course is to take care of the wear that may take place in the joints of the linkage and also to permit of some springing of the levers while the governor is forcing the valve on its seat. Otherwise, the governor may be exerting all its force upon itself instead of on the governor valve.

Speed adjustment is made by means of adjusting nut (30), Fig. 2 at *A*. This contains a cotter pin for locking it properly in position. Adjusting nut can be easily reached by removing cover (15).

Speed regulation may be changed by increasing or decreasing the number of active turns in the spring. The fewer active coils of the governor spring the greater will be the scale of the spring and the greater the speed variation. The nut (31) may be screwed further into the spring, thus reducing the active turns and increasing the regulation between no-load and full-load, as desired. Unscrewing (31) has the opposite effect, or that of making of less regulation between no-load and full-load. Especially close regulations could be avoided as the force of the governor is reduced and smooth operations may be undesirably affected.

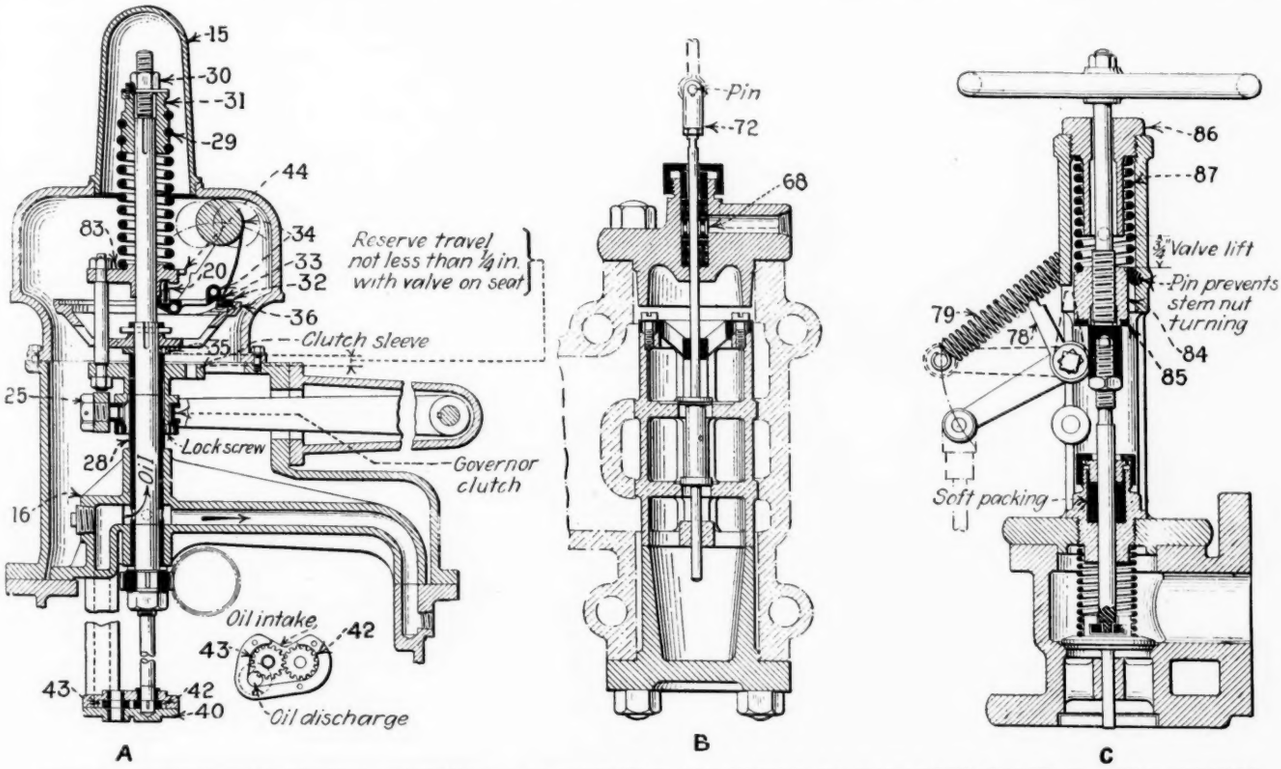


FIG. 2—COMPRESSION SPRING GOVERNOR *A* IS DIRECTLY CONNECTED TO BALANCED VALVE *B*. TWO SPRINGS INSURE QUICK CLOSURE OF EMERGENCY THROTTLE VALVE *C*

Valve Closely Balanced by Line Contact

The governor valve, Fig. 2 at *B*, of the Westinghouse sets may be carried in the same casing as that used for the throttle-valve body, or it may be in a separate casing. This governor valve is balanced against steam pressure by making the upper seat in the cage a right angle and the corresponding seat on the valve at 45 deg. The lower seat of the valve is, as nearly as possible, the diameter of the bore of the upper seat in the cage. This construction gives line contact between the seat and cage, and the diameter of the circle of contact is the same on the upper and lower seat, so that the valve is balanced. This type of valve does not lend itself to much grinding. Should it be necessary to grind any appreciable amount so that the sharp corners become beveled, they should be restored to their original sharpness by taking a slight cut off the top face of the cage and the same amount off the lower face of the valve.

The governor valve stem is made as small as possible to reduce the leak where it passes through the gland and a special form of metallic packing is used. This gland is practically a double gland with a leak-off space (68) between the two portions. This gland should never be adjusted when the turbine is in operation as it is possible to so tighten the gland that the governor cannot move the valve.

Always make the adjustment after the turbine has been shut down. When doing so, disconnect the valve stem from the lever and be sure that the valve moves freely before reconnecting it. If the valve sticks a little, pull the stem up and down a few times until it frees itself. Do not add some soft packing in the top of this gland and do not replace the metallic packing by some soft packing, for by doing so you may cause the gland to seize the stem and permit the turbine to overspeed.

Each of these geared units is provided with flood lubrication quite similar to that on large Westinghouse turbines. The bottom of the gear case serves as an oil reservoir, and all the oil drains back automatically to this reservoir. The cooling coil is mounted in the bottom of this reservoir, and water is circulated in the cooling coil to prevent too great a rise of the tempera-

ture of the oil. The governor stem is extended down and drives a small geared pump with meshing gears (42) and (43) mounted on an extension of the governor yoke. From this pump the oil is piped to the bearings and also to the governor yoke (16), Fig. 2 at *A*.

The oil under pressure in the yoke lubricates the two journals on the governor spindle. It also passes out of the governor spindle bushing (28) through holes provided and lubricates the clutch sleeve and the clutch pins (25). The oil from this governor pours out from

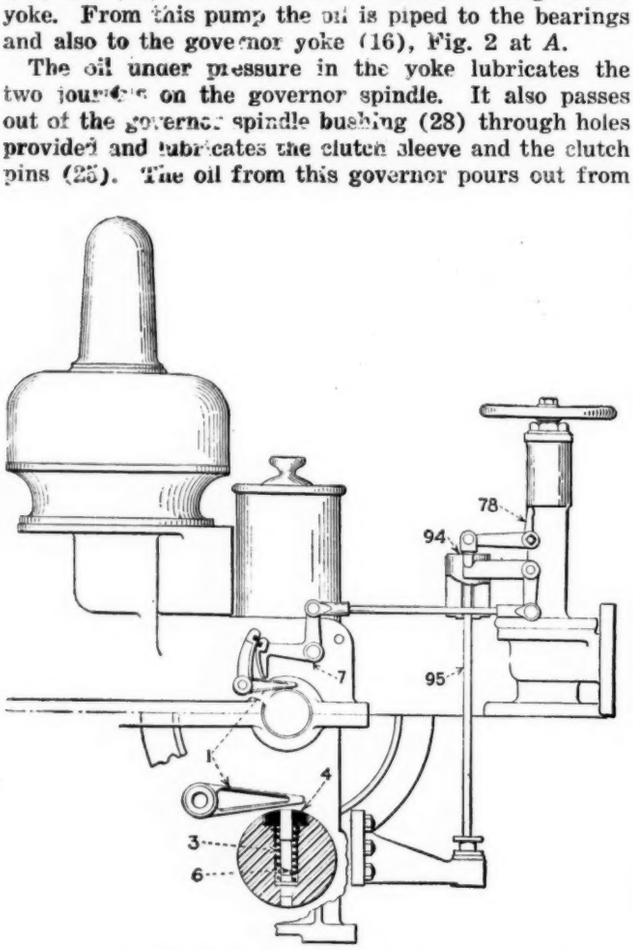


FIG. 3—EMERGENCY GOVERNOR RELEASES WEIGHT WHICH OPERATES EMERGENCY VALVE TRIP BY HAMMER BLOW

the various surfaces that need to be lubricated. Inasmuch as the whole governor is inclosed in the gear case which serves as a reservoir for the oil, this escaping oil does not cause any trouble.

Hammer Blow Trips Emergency Valve

The emergency overspeed governor which automatically closes the throttle valve at the overspeed for which it is set, is shown in Fig. 3 and consists of a hardened steel plunger (6) mounted at right angles to the axes of the turbine spindle in a rigidly bolted block. The center of gravity of this plunger (6) is arranged to be some distance out from the axis of the shaft, so that when the turbine is running the weight tends to be thrown out by centrifugal force, but is held in by a helical spring (3) which in turn is held in compression by a nut (4).

The design of the spring and the plunger are such that when the plunger begins to move out, the centrifugal force acting on it increases more rapidly, than the force exerted by the spring, owing to the increasing radius between the center of the shaft and the center of gravity of the plunger. This results in the weight coming out suddenly when once it starts, and fetching up against a stop which limits its travel to about ¾ in. The end of the plunger is then protruding through the shaft and strikes a lever (1) which is set with fairly close clearance between it and the shaft. The blow from the plunger throws the lever out, and that unlatches a weight (94) which falls on an enlarged portion at the bottom of a stem (95) connected to the latch (78) under the valve nut, and so permitting the spring to close the valve.

To increase the speed at which the overspeed device operates, insert liners between the spring and the nut (4). Do not put shims between the spring and the shoulder on the plunger (6), as this has the effect of changing the position of the center of gravity of the plunger. To reduce the speed at which the device operates, remove liners if there are any in place, or grind a little off the end of the spring.

To reset this automatic device, raise the throttle-valve nut until the latch engages. This is done by going through the motions of shutting the valve. After the latch engages, the falling weight may be restored to its place, and in so doing the linkage automatically latches.

Testing the Overspeed Device

This overspeed device should be tested periodically, say once a month, to make sure that it is in operating condition. Holding up the governor lever which connects to the governor valve stem will cause the turbine to overspeed. A turbine should never be overspeeded without measuring with a tachometer the speed to which the machine attains. If the device does not operate at about 10 per cent overspeed, the turbine should be shut down and the overspeed device examined to find the cause of the difficulty.

If, during the ordinary operation of the turbine, the overspeed device trips, the machine should not be started up again until the cause of the overspeeding has been determined and corrected. It is, of course, possible that the overspeed device has tripped because it was set too close to the ordinary running speed, but it is much more likely that it tripped because the turbine overspeeded, and the cause of this should be found and removed. Instances are known where the turbine overspeeded owing to the governor valve stem having been accidentally bent. When the overspeed device tripped, it was thought that there was something wrong with it and so it was rendered inoperative, and then the turbine started up again with disastrous results.

The throttle valve used on these small turbines is of the general construction shown in Fig. 2 at *C*. The respect in which it differs from an ordinary throttle valve is that the stem nut (84), which is usually fixed in the yoke, is, on the Westinghouse turbines, free to slide up and down in a bored space in the yoke. It is kept from turning around by one side being flattened and a pin put through the yoke opposite this flat surface. On top of the nut a helical spring (87) is mounted and compressed by the nut (86). The stem nut is raised up until supported on the latch (78), by going through the motion of shutting the valve, for when the valve disk comes on its seat it cannot go any further and the nut is therefore raised by the screw on the valve stem, by continuing the rotation of valve wheel.

When the stem nut it latched up, the throttle valve opens and shuts just like any ordinary throttle valve. Should the turbine overspeed a predetermined amount, the latch (78) is automatically pulled from underneath

the stem nut, as in full-line position, permitting the spring (87) to force the valve on its seat and shut off all the steam to the turbine. To prevent wearing out of the sharp edge on the lower face of the stem nut, a hardened steel ring (85) is provided and the supporting edge of the latch (78) is also hardened. The latch is pulled into place as in dotted position, by a light spring (79). The gland of this throttle valve is packed with any good soft packing. The adjustment of this gland should not be changed without afterward tripping the valve to see that the spring is capable of forcing the valve to its seat against the friction of the gland.

Motorship Has Low Fuel Consumption

The Shipping Board's records reveal that the "William Penn," a twin-screw motor ship engined with two 2,100-i.hp. Burmeister & Wain Diesels, had shown a fuel consumption of approximately one-third that of an oil-burning steam vessel, the "Ethan Allan," having the same general dimensions.

	"Ethan Allen"	"William Penn" Voyages		
Voyage number	54	1	2	3
Number of ports called	21	18	15	18
Days at sea between pilot stations	88.7	109	104	96
Total distance steamed	22,951	27,769	26,977	28,317
Average speed between pilot stations	10.78	10.65	10.83	11.29
Total fuel at sea	3,220	1,419	1,394	1,395
Total fuel in port	1,059	93	106	73
Total fuel, sea and port	4,279	1,512	1,500	1,488
Miles a ton of fuel	7.12	19.6	19.3	20.29
Average daily fuel at sea, tons	37.47	13.04	13.04	14.53
Average daily fuel in port, tons	.....	29.79	.75	1.08
Average daily fresh water	9.9	2.4	3	2.16
Total cost voyage repairs, engine room	$3,501	.....	.....	$112
Total cost voyage repairs, deck machinery	.....	$393	.....	.....

The comparison shows that on a ton of fuel the "William Penn" can cover two and three-quarter times the distance covered by the "Ethan Allen." Unfortunately, the steamer's recorded port consumption is unusually high due to the necessity of maintaining steam pressure for emergency purposes while in Oriental ports. This is not required by the motorship, and a direct normal comparison, therefore is not possible. It may be stated, however, that fuel port consumption of the average steamer is from 10 to 12 times that of a motorship.

It must be admitted that the foregoing comparison leaves no doubt as to the substantial savings in fuel, water, engine-room wages and subsistence realized by the motorship, not to speak of other indirect advantages such as increased cargo capacity and greater flexibility of operation with consequent smaller operating expenses. As the sale of good hulls at a nominal price makes possible their conversion at a cost but little higher than newly built foreign steam tonnage and much less than foreign-built motorships, it follows that by the possession of high-grade vessels of low initial cost, the American shipowner is at once placed in the privileged position heretofore enjoyed by his foreign competitors.

One common practice that is more or less of a mistake is the selection of steam traps by pipe size. It should be unnecessary to refer to this at this age and date, but the practice still goes on. One would not think of selecting his engine or turbine or pumps according to the size of the steam-inlet pipe, but rather by the work he wishes to do or according to the horsepower it is desired to develop. So steam traps should be specified not by the size of the drip, but rather by the amount of radiation to be drained or the condensation to be handled. In short, steam traps should be specified according to the capacity required for the pressure involved and the particular character of the service.

More Power with Less Coal at Saxony Mills Plant

New chain-grate stokers in enlarged combustion chambers and the addition of a mixed-pressure turbo-generator to Corliss-engine rope-drive plant, improve economy and increase the capacity.

Recently it became apparent to the Saxony Mills, flour millers, of St. Louis, that the power plant was fast becoming inadequate for their needs. The equipment consisted of two 2,500-sq.ft. water-tube boilers, set over inclined-grate stokers, the boiler-feed water being provided through a steam plunger pump. An 18 and 28 by 42-in. heavy duty tandem-compound Corliss engine,

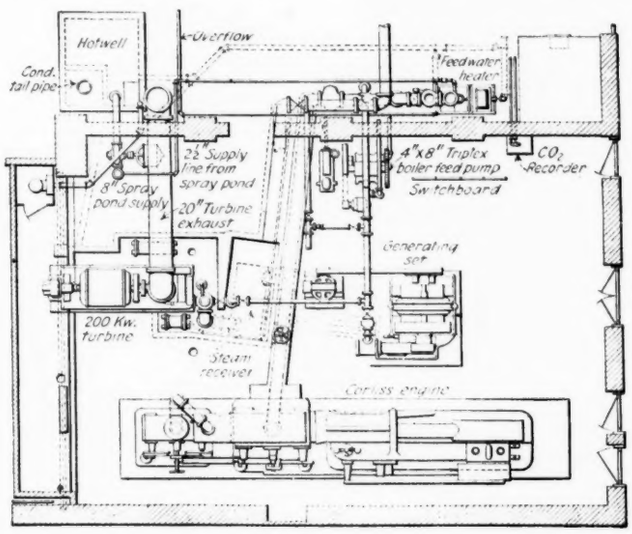


FIG. 1—GENERAL LAYOUT OF REMODELED ENGINE ROOM

operating at 80 r.p.m. non-condensing, furnished power to the mill through a rope drive. Electric power was supplied by a 10x10-in. simple slide-valve engine directly connected to a 40-kw. three-phase alternator, this power being used for mixing, elevating and conveying machinery and for plant lighting. These requirements loaded the generator to its full capacity, so that no power was available for a proposed expansion.

It was observed that while the boilers were in excellent condition, the stokers had outlived their usefulness and repairs necessary to put them in condition would be nearly equal to the cost of new ones; also that the combustion space provided was inadequate, being considerably less than prescribed in present-day practice. As the time during which the plant could be shut down was limited, it was decided to install chain-grate stokers, as they could be obtained locally and delivered immediately and were well adapted for burning Illinois coal.

To provide the necessary combustion space, the head room was increased by excavating a large pit in front of the boilers. This was made deep enough to give the required height to the combustion chamber and long enough to allow removal of the stokers and provide space for coal storage and ash removal. Aditional equipment installed consisted of a metering feed-water heater and a motor-driven triplex boiler-feed pump.

A study of the power situation showed that tne

exhaust from the Corliss engine, if used in a mixed-pressure turbine, would furnish sufficient electrical energy for the present mill and also for the proposed expansion. A flat roof over a train shed provided an ideal location for a spray pond for cooling the condensing water. Accordingly, a 200-kw. mixed-pressure turbo-alternator, served by a high-level barometric jet condenser, was installed. The condenser discharges to a hotwell in a corner of the boiler room, from which the condensate is raised by a motor-driven centrifugal pump and forced through the sprays placed on the roof of the train shed. From the down spouts of this pond the cooled water is piped directly to the injection lines of the condenser, as the height of the pond makes a pump unnecessary. A float valve is provided on the suction line of the spray pump to maintain a constant level in the hotwell and to prevent loss of water through overflow.

As the plant operates only 12 hours a day, a combination surge and storage tank was provided inside of the building, so that in cold weather the pond and injection piping can be drained to prevent freezing. The elevation and capacity of the storage tank were so gaged that when the condenser is shut off and the spray pump is stopped, it is full of water. The drain from the injection line is piped to the hotwell, so that when it is necessary to drain the system, little water is lost. A tap from the discharge line of the spray pump is made to the feed-water heater, so that not only is the benefit of the heat in this water obtained, but pure water is supplied to the boilers. Operating experience has shown that a ¾-in. line supplying cooling water for the turbine oil gives all the makeup water necessary, even in hot weather.

To provide the necessary data so that the operator can maintain the highest efficiency at all times, the plant is equipped with flow meters, draft gages, flue-gas thermometers and a recording CO_2 indicator.

Continued operation since the new equipment was installed has shown a substantial saving in coal owing to greater furnace efficiency; the saving in steam consumption is indicated in the steam-flow-meter chart. In the morning the daily routine begins by starting the small engine set to furnish light for the mill. Then the main engine is started and run non-condensing for a short time, as was done in regular operation before the improvements were made. The turbine is then started on high-pressure steam, but almost immediately is changed over to low-pressure, condensing operation. At this time a large drop in the steam consumption is evident.

The improvements to the plant were designated and the construction supervised by the Larkin Engineering Co., of St. Louis.

MECHANICAL EQUIPMENT OF SAXONY MILLS PLANT

BOILERS AND AUXILIARIES

Two hor. water-tube boilers, 2,500 sq.ft.	Heine Boiler Co.
Two chain grates, natural draft,	Laclede-Christy Clay Products Co.
Stoker drive, vertical steam engine	E. H. Wachs Co.
Heater, metering type, 20,000 lb. per hr.,	H. S. B. W.-Cochrane Corp.
Feed pumps:	
One 6 x 4 x 6-in. outside packed, duplex steam,	Fairbanks, Morse & Co.
One triplex pump, G. E. motor	Goulds Manufacturing Co.
Soot blower	Bayer Co.
Ash conveyor, steam-jet	Conveyors Corporation of America

POWER EQUIPMENT

Mill engine, 18 x 28 x 42-in., tandem-compound, heavy duty,	Murray Iron Works
Generators:	
One 40-kw. 3-phase 60-cycle 250-volt 300 r.p.m.,	Western Electric Co.
Drive, 10 x 10-in. slide-valve engine	Chuse Engine & Mfg. Co.
One 200-kw. 3-phase 60-cycle 250-volt 3,600 r.p.m.,	Allis-Chalmers Mfg. Co.
Drive, 300-hp. mixed-pressure turbine	Kerr Turbine Co.
Spray pump centrifugal	Lecourtenay Co.
Motor drive	Western Electric Co.
Spray-pond equipment	Spray Engineering Co.
Condenser	Worthington Pump & Mach. Corp.

MISCELLANEOUS EQUIPMENT

Valves	Chapman Valve Mfg. Co.; Jenkins Bros.
Atmospheric multiport relief valves	H. S. B. W.-Cochrane Corp.
Expansion joint, turbine exhaust	E. B. Badger & Sons Co.
Steam traps	Strong, Carlisle & Hammond Co.
Draft gages	Defender Automatic Regulator Co.
Flue temperature recorders	Defender Automatic Regulator Co.
CO_2 recorder	Republic Flow Meters Co.
Steam-flow meters	Republic Flow Meters Co.
Electric switchboard	C. J. & F. E. Briner
Electric switchboard instruments	Roller Smith Co.; General Electric Co.
Pipe covering	Johns-Manville, Inc.
Piping contractors	Urbauer Atwood Co.; American Power Piping Co.

Power Station for the British Empire Exhibition

Work has been started on the power station for the supply of electric energy tb the British Empire Exhibition to be held at Wembley Park next year. The power station, which itself forms one of the exhibits in the Electrical and Allied Industries section of the Palace of Engineering, will include three 1,500-kw. turbo-generator sets supplied with steam from water-tube boilers of two different makes.

Each of the turbo-generators will be constructed by a different firm and the switch gear, condensing plant and auxiliary machinery generally will also be the work of several different firms. In addition a steam-driven dynamo and another driven by a horizontal internal-combustion engine, each of 300 kw., will work on the stands of the makers in the main hall and will be connected up to panels on the power station switchboard. The whole of the electrical and allied engineering section of the exhibition has been organized by the British Electrical and Allied Manufacturers' Association.—*Engineering*, Oct. 5, 1923.

There are many kinds of mixtures that go by the name of "babbitt." The metals used to make babbitt are tin, copper, antimony, lead and zinc, in a variety of compositions; different mixtures will serve different purposes. Anyone can make his own mixtures if he has the facilities. The accessories required to prepare a mixture without copper in small quantities are a forge, ladle and some ingot molds. For larger quantities and for alloys containing copper one or more crucibles and a furnace will be required. The composition of genuine babbitt is generally taken to be 89 parts tin, 3 copper and 8 antimony. This is a good all-around mixture, largely used on engine work; its expense is a small item where wearing quality is to be considered. Copper requires a high temperature for melting. For this reason for repair jobs alloys of zinc and tin in the proportion 80 zinc to 20 tin, or of lead, antimony and zinc in the proportions of 78, 20 and 2 may be used for moderate pressures and speeds. The metal having the highest melting point is melted first, and the others are added gradually. The molten mass must be stirred to make the mixture uniform; otherwise the heaviest metal, like lead, will remain at the bottom.

EDITORIALS

F. R. LOW, EDITOR

Education for the Operating Engineer

THE live operating engineer wants the kind of training that will enable him to make good on his job. In the last analysis he, like other ambitious men, is looking for increased recompense in the form of financial reward, the confidence of his employers and the personal satisfaction that comes from a job well handled.

Good operation is an art, but an art that is based to a considerable extent on exact scientific knowledge. While he is obviously unfitted to accept immediate operating responsibility, it often happens that the man who leaves college to start at the bottom reaches a responsible position in a few years, passing fellow workers who have served long and faithfully. The lesson is plain. Such examples show that it is impossible to progress far in power-plant operation (or in any other engineering field, for that matter) without knowing both theory and practice. Neither alone will do the trick.

The technical graduate, granted that he is otherwise naturally suited to the kind of work, inevitably picks up the practical details if he gets a job where he is brought into direct daily contact with operating problems. Thus he rounds out his theoretical training with practical experience. The operating man can do the same with the theoretical side, with the one difference that technical competence does not come automatically as does practical experience; he must deliberately go after it. Some engineers have long realized this and, as a result, now hold positions of great responsibility. Others are just coming to see this truth and are taking the first steps in a course of action that will almost certainly lead to their advancement.

Yet many a practical man still clings to the exploded idea that the college graduate has something in the way of education that is not open to him. A little investigation will dispell this fallacy. Every educated man is *self* educated whether he went to college or not. The college may "lead the horse to water," but he must do his own "drinking." Most of the theoretical knowledge a man acquires in college he digs out of his textbooks. As almost any graduate can testify, the lectures of his instructors were of secondary value.

Sweeping aside the glamour that surrounds this whole matter of "higher education," the essential facts are simply these: For four years a man subjects himself to the supervision of a body that prescribes certain books and forces him to study them. There is nothing to prevent anyone from buying the same books and being his own taskmaster. With reasonable tenacity he can cover the same ground and do it more thoroughly. He may, it is true, get stuck occasionally and need help over the hard spots, but almost every community contains men able and willing to give just such help. They are to be found in every organization of engineers.

The total number of books covered in a four-year course is relatively small. Eliminating the non-technical subjects and those designed to give the student a speaking acquaintance with practical matters already well known to operating engineers only a small armful is left. Nothing in the world prevents any engineer from finding out what these books are and setting himself the task of mastering them. By giving up a few movie shows he can, in the course of four or five years of spare-time study, cover the essentials of the college course and go on to "post-graduate" studies. If study comes hard, good correspondence schools stand ready to furnish guidance and a certain amount of driving power.

Any operating man who is inclined to be skeptical of the immense value of such study, has only to look around in his own profession to see outstanding leaders who refused to remain "uneducated" for the lack of a few years in college.

The Case of the Reciprocating Steam Engine

IT WAS only a few years ago that the appearance of the steam turbine with its better efficiency and cheaper construction dealt a serious blow to the prestige of the reciprocating steam engine. Since that time the horsepower of engines installed each year has steadily shrunk, although the advent of the unaflow type has given somewhat of a new lease on life. The questions for engineers to solve are how the steam engine is to survive and the ways and means of improving its comparative efficiencies.

There is but little hope of increasing the mechanical efficiency, for the amount of frictional losses is already low. The unaflow construction has reduced the thermal losses in the cylinder until the thermal efficiency of the engine is equal to or better than that of a turbine under like operating conditions. The drawback lies in the inability of the reciprocating unit to make use of a low vacuum. Even if the enormous cylinders required by a low vacuum were mechanical possibilities, the cost of manufacture and the investment in the floor space would largely prevent their use in central stations.

On the other hand, the reciprocating engine has a broad field of usefulness in those plants where load conditions are unsuited for turbine drive, where exhaust steam is used, where process heat is required and in plants where condensing operation is not possible.

The high starting torque required in steel rolling mills, rubber works and like industries precludes the general adoption of the turbine, and the better efficiency of the engine in the high-pressure expansions enables a greater amount of power to be delivered at the switchboard per pound of steam passing through the cylinder in plants needing process steam. In non-condensing operation, the turbine has a high steam consumption which makes its use well-nigh prohibitive. Even in a combination power and steam-heating plant where the

power is frequently assumed to be obtained without cost, the engine will show a higher over-all efficiency during periods of light exhaust-steam demand.

It is apparent that the reciprocating steam engine is far from being threatened with extinction and will for years be found in general use where the conditions are favorable.

The Small Plant not the Only Offender

THE small steam plant has been accused of being the chief offender in uneconomical operating methods, which have resulted in burning five pounds of coal where one could do the same work in a large, efficiently operated station. There is much truth in this statement, but there come to light reports of large plants that have been rebuilt or remodeled or have had economical operating methods introduced that have produced astounding results. When a station that has been burning about fifty thousand tons of coal a year can, by rebuilding the plant, reduce the fuel burned by more than fifty per cent and the labor by seventy-five per cent for the same output, there can be no doubt that the small plant is not the only guilty one.

Attention has been called in these columns in the past to many instances where large savings have been made in various ways in large industrial plants. In this issue is another story which probably is as remarkable as any, since a saving of three hundred thousand dollars a year has been realized, largely by improved operation. An investment of about fifty thousand dollars was required to make possible the improvement, an almost insignificant amount compared to the returns. Before this change was made there were five coal-fired and two waste-heat boiler plants with a total of fifty-eight boilers in service. By efficient operation it has been possible to shut down thirty-eight boilers in four plants and to cut the coal consumption about fifty thousand tons a year for the same output. The cost of making this change was not due so much to installing new equipment to improve operation, as to transfering the load from the boilers taken out of service to those now in operation. The improvements made in the efficiency of the waste-heat boilers undoubtedly reflected favorably on the improvement in the coal-fired boilers in so far as a reduction in coal consumption for the whole plant is concerned. However, the fact remains that it was possible in this plant to save three hundred thousand dollars a year by introducing efficient operating methods in the boiler rooms.

In this case, as in others where large reductions in operating costs have been made, capacity has been concentrated into a few units and the right kind of men have been put into the plant. Where a station has a great many small units, the most efficient operation cannot be expected if for no other reason than that the cost of the necessary equipment would be excessive. The cost of equipping a large boiler with the necessary devices to give an intelligent record of operation is not greatly in excess of that for a small one, but the large one may be capable of supplying from ten to thirty times the load of the small unit. Furthermore, the large unit will not require a great deal more attention than the small one for efficient operation. There are plants that have a large number of small units that are operating with fair efficiency considering the handicap they are working under; in fact they are doing better than some others that are more favorably equipped. Efficient operation is a matter not only of installing equipment for obtaining records and automatic operation, but of making intelligent use of this equipment. This means putting the right kind of men in the plant and giving them something to work for, which has been done in the case reported in this issue.

Engineers' Comments Desired at an Early Date

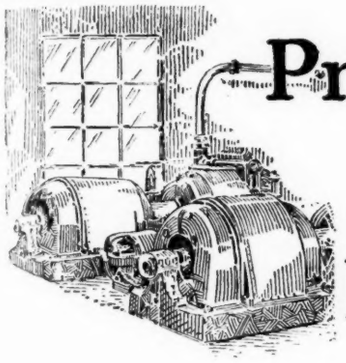
THE proposed standards for steel flanges for 250, 400, 600 and 900 lb. steam pressure and 750 deg. F., are expected to be presented for general discussion on November 21. Individual comments are invited. While few have had experience with piping under these conditions, there are many points where one's experience may suggest an improvement or a warning of possible danger to be avoided. Among the questions involved are: Should bolts be of mild or of alloy steel? When alloy steel bolts are used, how may it be possible to substitute mild steel bolts temporarily in an emergency? Should bolts be preferred to studs, and should the shanks be turned to root diameter? What stresses are safe for forged and cast steel at 750 deg. F., and how may these be checked?

The proposed standards may be obtained from one of the sponsor organizations after November 24—Committee of Manufacturers on Standardization of Fittings and Valves, the Heating and Piping Contractors National Association, and the American Society of Mechanical Engineers. A list of standardized pressures appeared in the November 6 issue.

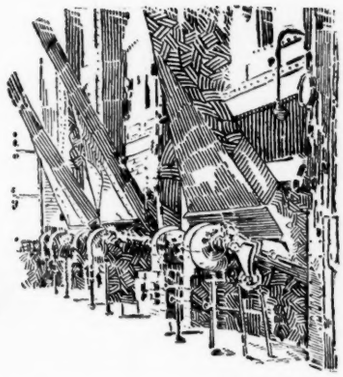
Unfortunately, only a few days will elapse before the meeting of the Sectional Committee in the Engineering Societies Building, December 6, at New York. It is hoped that all who may assist with suggestions or comments will kindly obtain this specification and communicate with any of the sponsor organizations in advance of December 6 if possible. In all probability the standards will be reported in the November 27 issue of *Power*.

Standards, generally, are subject to a somewhat complicated ordeal. The need for those of pipe flanges and fittings at higher pressures and temperatures arose in commercial practice. The sponsor organizations who recognized this need, appointed a sectional committee for their development, under the procedure of the American Engineering Standards Committee. The personnel of the Sectional Committee is as broadly representative as possible; its forty-eight members officially representing twenty-three organizations, and it has been approved by the A.E.S.C.

The detailed work of preparing the standard dimensions and specifications of materials is carried on by subcommittees. When one of these subcommittees has completed its report, the report is circulated by mail to the members of the full Sectional Committee and a date is set for discussion at an open meeting. In this case Subcommittee No. 3 is expected to complete its report November 21, so a meeting of the Sectional Committee has been called for December 6. Following this general discussion, the standards will be revised if necessary and sent to each member of the Sectional Committee for vote by letter ballot. Following this vote, the report goes to the Sponsor bodies, and on their approval to the A.E.S.C. for designation as a tentative American Standard.



Practical Ideas *from* Practical Men



Industrial History in the Making

My continuous working in a machine shop began at Plattsburgh, N. Y., in 1853 when I was very young. I realize now, as of course I did not then, that the shop was strenuously employed in a detail of the making—or the unmaking—of the industrial history of the Empire State. The destruction of the Adirondack forests was proceeding in the most ruthless fashion with no thought or care for consequences.

Three lines of destructive activity were vieing with one another in the devastating work. The sawmills strung along the Ausable and the Saranac Rivers and in a more wholesale way on the upper Hudson, were devouring the magnificent pines, the tanneries were felling the hemlocks for the sake of their bark, and the charcoal-iron forges were burning without discrimination all the timber they could reach. The machine shop was providing and maintaining the mechanical equipment for all these industries, and the business was without let up for many years, although dead enough now. These interests provided employment for the shop in wide variety, besides which there were local grist mills, potato-starch factories and other stray activities to which we were called to cater. Small water powers were numerous, and we made many horizontal turbines cast in a single piece with efficiencies of little account. I am reminded, however, that the machine shop was driven by a vertical turbine that would be respected even today.

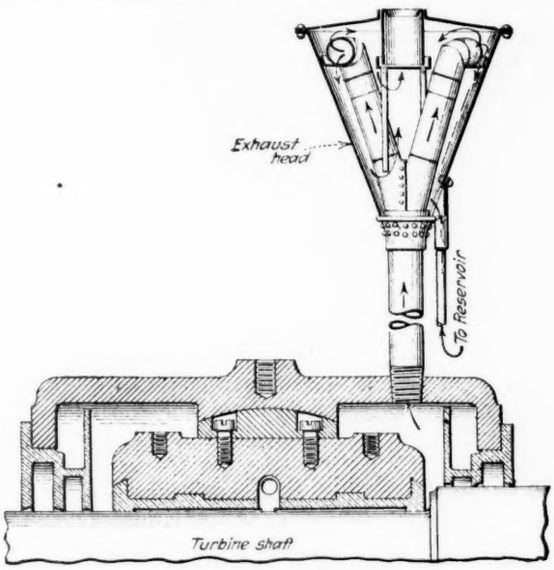
We also built steam engines without any of the later refinements or economies; plain slide valve, with little or no lap, and a butterfly throttling governor. One of these, designed to drive a grist mill and incidentally a wool-carding machine, I was permitted to participate in the erection of, at Napierville, over the Canadian border. This village was entirely French, and when the engine equipment was completed the proprietor had it cried, from the church steps on Sunday, that it was ready for business.

An engine of the then familiar type drove a large lumber planing mill near the lake front, using the shavings for its only fuel and furnishing a superabundance of power not only for the planing, but also for various incidentals—cutting the boards to uniform length, tonguing and grooving, sawing laths, etc. This engine had been installed before my father's time there, and it was heartbreaking to him to note the reckless wasting of the steam. The owners were persuaded—I don't know what arguments were used to fit the circumstances—to allow the placing of a Farcot cutoff (I think that's the name) on the slide valve. A new valve was made with a face so long that it would never uncover the steam ports of the cylinder, and with two steam passages up through the valve. Then a plate valve was made to ride upon the main valve, alternately uncovering the steam passages through the latter, but when this riding valve struck a fixed lug at either end of the chest, the steam passage through the valve at that end was closed and the steam would be cut off before the piston had made a quarter-stroke. The valve was not a new idea or in any way experimental. It worked all right, cutting off as planned with still an abundance of power for all requirements. The unfortunate part of it was that it *saved too much steam.* They could not burn the shavings fast enough, and the riding valve rode only for about a week.

Plainfield, N. J. FRANK RICHARDS.

Reclaiming Oil from Vapor in Turbine Bearings

It is often desirable to pipe air vents to the bearings of steam turbines, particularly in medium and large sizes. This is for the purpose of relieving the air pressure set up by revolving members. Ordinarily, the vapor



OIL SEPARATED FROM THE VAPOR IN THE EXHAUST HEAD AND WAS DRAINED BACK TO OIL RESERVOIR

which passes through such a relief vent is heavily charged with oil. In the case of large machines it frequently happens that an appreciable amount of oil is lost through discharged oil and air vapor.

A convenient means of separating the air and oil vapor is shown in the illustration. In this case the

vapor was piped to a 4-in. exhaust muffler of standard make. It was found that this readily separated the oil from the air in the discharged vapor. The oil trickled to the bottom of the muffler, and a small pipe conducted it to the main oil tank at the base of the steam turbine. An appreciable saving in turbine oil was made by piping the oil vents of each bearing in this manner and conducting the reclaimed oil to the main oil reservoir.

Paterson, N. J. J. F. WHITE.

Overloading Diesel Engines

The impression is quite prevalent among engineers whose experience has been confined to the operation of steam-driven units that an overload on a Diesel engine is an impossibility in practice. This is wrong, for most oil engines will carry loads considerably above their ratings.

As an example of the Diesel's ability to carry an overload, attention is called to the indicator diagram shown in the illustration. This was taken from a

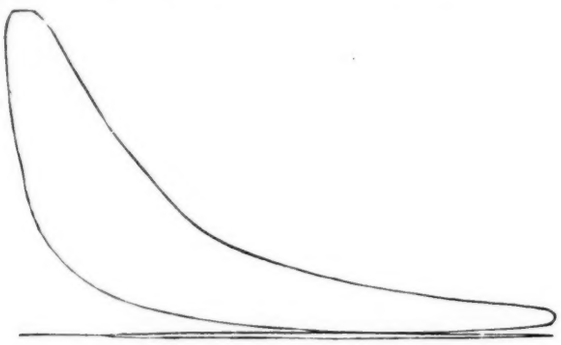


DIAGRAM OF DIESEL OVERLOADED 33 PER CENT

McIntosh & Seymour Diesel running at 164 r.p.m., the engine being rated at 500 hp., but at the time the diagram was taken the load was 668 hp. The combustion line is remarkable for its fairly constant pressure. It is usual to see a Diesel, even when carrying only full load, have a sloping combustion line. The unevenness in the expansion line is probably a result of the indicator piston's sticking, although it could have been produced by after-burning. The load of 668 hp. represents an excess of 33 per cent above the normal rating. This was the maximum possible to secure without occasioning a decided drop in the engine speed.

Experience shows that practically all Diesel engines are capable of developing a marked overload, 25 per cent over-rating representing the usual overload ability of the engine. If this excess is required for only a short time, there is no reason why the engine should hesitate about boosting up the load to this figure. With such abnormal conditions strict attention must be given to the cooling water. While the discharge cooling water in ordinary operation can be carried at 130 to 140 deg., with an overload the water circulation must be increased and the discharge temperature kept as close to 100 deg. as possible. If the temperature is allowed to remain high, there is serious danger of piston seizing.

There is no gainsaying that any type of oil engine shows a better total over-all efficiency when carrying a constant load of some 85 per cent of the rating. Even if the load but slightly exceeds the normal rating, the stresses set up because of the heat conditions usually evidence themselves by the engine's requiring a much greater effort from the engineer in maintenance work. Most of the fractured pistons and cylinder heads that are not caused by faulty water cooling are directly attributable to heavy load conditions. J. SPUGG.

St. Louis, Mo.

Isolated Plant Power Costs

The subject of isolated plant power costs is one that should be of interest to every engineer in charge of a plant generating power as a main product or as a by-product of the steam plant. Power costs should be especially interesting to the small-plant engineer, for as a rule small plants are less efficient than large ones. Poorly operated and inefficient small plants form one of the best leads for the approach of the central-station expert with his proposition of low power costs and guarantee of continuous service. Undoubtedly, there are many plants operating today on central-station energy that would be sending out their own power on an economical basis had the engineers been fully prepared to checkmate the advances of the central-station man with complete data on power costs for their particular plant.

The figuring of power costs is quite a big subject, and each plant has its own problem which must be worked out. No fixed rule or formula can be set down to apply to every case, because no two plants are exactly alike in equipment and diversity of load; both steam and electrical. Some will purchase their water supply at so much a thousand gallons, while others will pump their own water, possibly having a city water connection in the building for emergency use.

Various items entering into the calculation of the cost of power may be roughly classified under two heads, operating costs and fixed costs. The following list is a sort of standard used in figuring these costs.

Operating Costs: (1) Salaries of engineer and all engine-room and boiler-room help directly connected with the production of power; (2) cost of coal, hauling, etc.; (3) removal of ashes; (4) water; (5) oil; (6) tools, packing, lamp renewals, waste, etc.; (7) repairs to boilers; (8) repairs to engines and generators; (9) miscellaneous operating expenses; (10) miscellaneous supplies; (11) general expenses. The last-named include a part of the executive officers' pay and all who have anything to do with superintending or buying for the plant, and such bookkeeping expenses as may be necessary.

Fixed Costs: (1) Depreciation, usually figured at 5 per cent on the total costs of boilers, engines and generators, buildings, smokestack, etc. (2) interest, 5 per cent of total investment; (3) taxes, 3 per cent of total investment (state and county); (4) insurance, 5 per cent of total investment (this should include liability, fire, and accident insurance); (5) rental. By this is meant the value of the space being used by the plant itself. In some cases this is of little value. In many instances, however, the generating plant takes up valuable space and a yearly amount, equivalent to what this space would bring in if rented, should be charged against the plant; (6) risk to employees. This item should be included for the reason that damage suits resulting from injuries to employer are always being brought and will always be added expense to the insurance items; (7) breakdown charges. In

some plants where continuous service is essential, a central-station switch is installed. In this case the central station makes a regular monthly charge for being ready to supply current when called for.

In the foregoing list such items as depreciation, interest, etc., should be figured on the total investment of the plant. As a rule, it will be much easier to figure the items for a year, including operating expenses, output, etc. When a monthly basis is preferable, simply divide by 12.

For the large plant equipped with recording wattmeters, flow meters, water meters, etc., to register the amount of each item entering into the cost of power, fairly accurate costs may be obtained. For the small plant having none of these accessories, the various costs are not easily arrived at, and in many cases a close calculation based on good judgment is the best that can be accomplished.

The following simple case is worked out to show the proper relation of the various items enumerated. Assume a plant to be generating an average of 300 kilowatts, 12 hours a day and 300 days a year, or a total of 3,000 hours. Water is purchased at 10 cents per thousand gallons, and the total cost of the power plant is to be $50,000.

To arrive at the total output of the plant in kilowatt-hours per year, when no meters are installed, if direct-current is generated, ascertain the average load on the switchboard ammeter and multiply this reading by the voltage of the system and divide by 1,000 to reduce to kilowatts. Assume the average ammeter reading to be 1,363 and the voltage 220. The output per hour would be $\frac{1{,}363 \times 220}{1{,}000} = 300$ kilowatts; $300 \times 3{,}000 =$ 900,000 kw.-hr. per year.

Fixed Costs: Depreciation at 5 per cent; interest at 5 per cent; taxes at 3 per cent; insurance at 5 per cent; total, 18 per cent of $50,000 = $9,000 total fixed costs.

Operating Costs: Labor, oil, tools, miscellaneous supplies, etc., may be set down at $6,850. Removal of ashes, $200 per year. Repairs to boilers, engines and generators, $300.

Coal: The cost of coal chargeable directly to power will depend on a number of variables: (1) The cost of coal; (2) the efficiency of the boiler, or pounds of steam per pound of coal; (3) the steam consumption of the engines per kilowatt-hour; (4) the percentage of the total yearly amount of exhaust steam used in the heating system. The cost of coal (1) is taken at $4.50 per ton. The efficiency of the boiler (2) is taken at 60 per cent, or about 8 pounds of steam per pound of coal. The steam consumption of the engines (3) will vary, averaging from 26 to 30 lb. per hp.-hr., or from 35 to 40 lb. per kw.-hr. In order to take care of fluctuating loads, it is best to assume the steam consumption between 50 and 55 lb. per kw.-hr. The exhaust steam used for heating (4). When no exhaust steam is used for heating, all coal burned is chargeable directly against power. When the heating season is on, the coal chargeable to power is the coal equivalent of the heat lost between the high-pressure boiler and the heating system. In a small plant it is hardly convenient to calculate the total heating required per year as so many B.t.u. of radiation or as so many pounds of steam. It is simpler to consider it on a basis of so many months of heating load (four, five or six months) during which time all exhaust steam is used for heating. There are times at the beginning and end of the season when only part of the exhaust from the engines is utilized. This condition may be taken care of by estimating a shorter heating season.

Assume a six months' heating season, during which time the coal chargeable against power is the equivalent of the steam and heat lost between the high-pressure boiler and the heating system. The heat of the steam lost in this manner due to condensation in high-pressure steam piping, engines, etc., may be set down at 20 per cent.

To calculate the complete coal cost we then have the following factors: Load, 300 kw.; cost of coal, $4.50 per ton; coal consumption, 1 lb. per 8 lb. of steam; 55 lb. of steam per kilowatt-hour per year, 3,000.

We therefore have the following as the cost of coal during the six months heating season:

$$300 \times \frac{3{,}000}{2} \times \frac{55}{8} \times 0.20 \times \frac{\$4.50}{2{,}000} = \$1{,}392$$

The cost of coal during the six months' period when no heating is used is charged entirely against power, as follows:

$$300 \times \frac{3{,}000}{2} \times \frac{55}{8} \times \frac{\$4.50}{2{,}000} = \$6{,}961$$

Water is purchased at 10 cents per thousand gallons. During the heating season practically all the water is returned to the boilers. There is probably some loss from various causes, and this item may be set down as 15 per cent. The cost for water during the six months of heating is then:

$$300 \times \frac{3{,}000}{2} \times \frac{55}{8.33} \times 0.10 \times \frac{10\text{c.}}{1{,}000} = \$30.15$$

The cost for water during the six months of no heating when all the exhaust is lost is as follows:

$$300 \times \frac{3{,}000}{2} \times \frac{55}{8.33} \times \frac{10\text{c.}}{1{,}000} = \$301.15$$

The total fixed and operating costs may now be tabulated in their proper order:

Fixed costs	$9,000.00
Labor, oil, supplies, etc.	6,850.00
Removal of ashes	200.00
Repairs	300.00
Coal	8,353.00
Water	331.30
Total	$25,034.30

The total yearly output of the plant is 900,000 kw.-hr., hence the cost per kilowatt-hour is $25,034.30 ÷ 900,000 = 2.78 cents.

Some plants may pump their water from a deep well or other source of supply. In this case a certain number of kilowatt-hours per month is used for this pumping and the cost of this amount should be estimated as nearly as possible and charged against plant operation. It should also be subtracted from the total output, and in this way the cost of the water can be added to the operating expenses just the same as if it were being purchased.

If live steam is used for manufacturing purposes, and no flow-meter is on the line, there is no way to determine the amount of steam so used except by careful estimation.

Practically every plant of consequence is equipped with a feed-water heater, but there should be no direct operating charge against it. It should, of course, be included in the total investment. **A. R. KNAPP.**

Louisville, Ky.

Comments from Readers

Grooves Preferable to Holes for Preventing Belt Slipping on Pulley

In the Oct. 9 issue O. Petterson explains how belt slippage was overcome by drilling a series of holes in the pulley face. Also he says that "this method is preferable to the use of grooves." I cannot agree with him on this point, however, for the following reasons:

1. It is necessary to make the diameter of the holes at least so large that the total sum of the openings will be equal to the continuous opening of a groove.

2. Owing to the centrifugal force the natural tendency of the air is to move outward instead of inward. A groove can permit the air to leave naturally with an "outward" motion.

3. Holes drilled in a pulley tend to weaken it, while a groove in the right place has no effect on the strength.

4. It is easier to clean the groove than it is to clean the holes. Simply hold a nail in the groove while the pulley rotates, and any dirt is quickly and easily scraped out.

L. W. LOWERRE.

Elizabeth, N. J.

The Invention of Poppet-Valve Engines

I read with interest the contribution of C. A. Joerger, on "Why Not More Poppet Valves in America?" in the Aug. 14 issue, also the comment of Mr. Odell in the Sept. 25 issue. Like Mr. Odell, whose reminiscences I have thoroughly enjoyed, I do not write in anyway antagonistic, but from the view of "honor where honor is due" and the recognition of one who was an ornament to the field of power.

It has generally been understood, and (with all respect to the veteran, Mr. Odell) I have never seen it contradicted before, that the invention of poppet valves, or as they were first known, drop valves, was due to the genius of the late Charles Brown, who was manager and practically creator of the works of Sulzer Bros., Winterthur, Switzerland, and who also fathered the idea of beautiful outlines and curves found in machinery, which has been envied and copied by designers throughout the world.

Charles Brown, an Englishman, was born in 1827 and early in life set up a small workshop of his own for the purpose of obtaining practical knowledge without serving a seven-years' apprenticeship in vogue at that time. Later he entered the firm of Messrs. Maudsley, London, remaining there until invited by Sulzer Bros., in 1851 to take charge of their works. Although only twenty-four years of age, he immediately set about a thorough reorganization of the works. The firm then employed seventy men, and in a few years, by reason of his many improvements and inventions, the employees totaled seventeen hundred, which was considered an enormous number at that period.

It is not known exactly how long it was after taking charge that Mr. Brown began experiments on his valve gear, but at the Paris Exhibition of 1867 Sulzer Bros.' drop-valve engines carried off all the highest awards. Like all real geniuses, Mr. Brown did not hide his light under a bushel, and it is safe to assume that he had made public his invention long before, which, it is claimed, was not only extensively copied throughout the world on account of the economy effected, but was the forerunner of many other allied motions. It is quite possible that Mr. Odell saw this motion at work as he states about 1869, and that it had been running several years previously and nevertheless was the invention of Charles Brown.

It might also be mentioned that on leaving Sulzer Bros. in 1871, Mr. Brown laid the foundation of the Swiss Locomotive Works and, with a modification of his valve gear, succeeded at the Paris Exhibition of 1878 in winning the highest awards for his locomotives.

Mr. Brown died Oct. 6, 1905, leaving behind a wonderful record of over fifty years' work and influence upon Swiss engineering in general, only twenty of which were spent in the works of Sulzer Bros. Shortly after his death the British journal *Engineering* in the Dec. 29, 1905, issue, published a full and comprehensive account of his life's work and his inventions, from which an extract appeared in the issue of the *American Machinist* dated Feb. 15, 1906, and if Mr. Odell or any other reader interested will look this up, he will find an interesting story of a man who, to quote Mr. Odell, "did his bit" throughout a long life. Also, I think, it will remove all doubt as to the real inventor of poppet valves and their adaptation to steam engines.

Belfast, Ireland. F. P. TERRY.

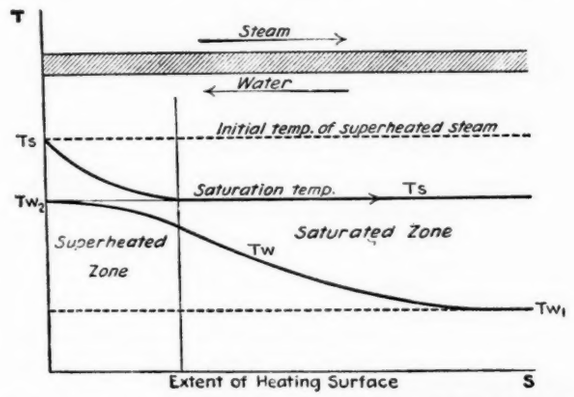
Using Superheated Steam in Closed Feed-Water Heaters

A method of de-superheating steam in closed feed-water heaters, for the purpose of increasing the rate of heat transmission, is described by A. G. Christie, in an article in the Sept. 14 issue. B. C. Sprague, in the Oct. 2 issue, takes exception to Professor Christie's statement explaining that the idea of expecting lower rates of heat transfer when superheated steam is used in evaporators and heaters is erroneous. That this assertion is quite contrary to results obtained with superheated steam in superheaters as well as in feed-water heaters is hardly to be questioned.

It is a known fact that the rate of heat transfer between a vapor and a liquid decreases as the vapor approaches the conditions of a perfect gas. Mr. Sprague describes two conditions at which heat transmission might take place; First, when the temperature of the film on the surface of the metal is above the temperature corresponding to the pressure of the steam (as in the case of superheaters), and second, when the temperature of the film is slightly less than the saturation temperature of the steam, a condition found in surface condensers and also usually in closed feed-water heaters. He states quite correctly that a low rate of heat transfer is to be found in the first case and that the heat

transfer is much greater when the temperature of the tube surface is slightly below the temperature corresponding to the pressure of the steam, as in the second case. Obviously, the steam gives up only part of its sensible heat during the process of de-superheating, as in the first case, and additionally its latent heat of vaporization in the second case.

To consider the effects of superheated steam on the rate of heat transfer in closed feed-water heaters three cases will be discussed briefly for heaters using superheated steam: (1) Water heated to nearly saturation temperature of the steam; (2) water enters at a temperature less than the saturation temperature of the steam and leaves at a temperature higher than the saturation temperature of the steam; (3) water enters at the saturation temperature of the steam or at a



SHOWS DIAGRAMMATICALLY CONDITIONS WHEN THE WATER IS HEATED TO NEARLY SATURATION TEMPERATURE OF THE STEAM

higher temperature and leaves at a temperature approaching that of the entering steam.

The conditions of case (1) are shown diagrammatically in the accompanying illustration. The heat exchange may be considered as taking place in two zones, the superheated zone and the saturated zone. The rate of heat transfer in the superheated zone is less than that in the saturated zone. It follows that the mean rate of heat transfer will be greater, if saturated steam is used initially, than it will be for the case under consideration. Mr. Christie's method for de-superheating the steam could be used to advantage here without sacrificing any of the available heat for heating the feed water. It is obvious that the effect of increasing the rate of heat transmission simply implies a reduction in the effective heating surface to be used for the same installation.

In case (2) it is necessary to retain the superheat, at least to a certain degree depending upon existing conditions. The mean rate of heat transfer for this case, as compared to the case where saturated steam is used whose temperature is that of the superheated steam, depends entirely upon the degree of superheat and the temperature limits of the feed water. In general, it may be said that the rate of heat transmission is greater if high-temperature saturated steam were used.

In case (3) the steam gives up only part or all of its superheat. It follows that for this case the rate of heat transfer is least. The steam must necessarily leave the heater as such and could be used in a second heater through which the feed water would pass before entering the heater under discussion.

Mr. Sprague writes: "When the tube temperature remains below the saturation temperature of the steam, the rate of heat transfer with superheated steam will be as high as that with saturated steam at the same pressure." (Obviously, this is not the case). Also he shows some results of tests to determine the effect of superheated steam on heat transfer in an evaporator. I can see no justification of his assertions and contentions in these data for these reasons: First, for the superheated condition takes the saturation temperature to determine the mean temperature difference, even though a high degree of superheat is used; secondly, the hourly quantity of water evaporated when superheated steam is used can be more than the amount evaporated with saturated steam without signifying any increase of heat transfer rate, because the relative heat quantities of unit weight of steam are greater than the relative amounts of water evaporated. It must be admitted that a rather mathematical expression defines the average steam temperature or the mean temperature difference for the case of superheated steam.

For closed feed-water heaters the temperature of the superheated steam is not constant, its heat loss per pound is small (1 lb. of steam at 15 lb. abs. and superheated to 550 deg. F. is cooled to 270 deg. F. and gives up only 132 B.t.u.), its volume is great and the cost of producing it is high. It seems, therefore, that the use of superheated steam in closed feed-water heaters is not to be preferred, although it must oftentimes be used when the water has to be raised to a temperature higher than the saturation temperature of the steam available. The writer believes that where steam is bled from turbines for feed-water heating, it would seem that superheated steam could be used to a greater advantage in the turbine than in the heater.

There is but little published information at present on the heat transmission between superheated steam and water, and although we know the general trend of the results to be expected, it offers a wide field for research, the results of which will be of interest to a great many engineers.

F. W. RABE, JR.,
Instructor Mech. Engineering Dept.,
New Haven, Conn. Sheffield Scientific School.

Catalogs and Advertising for the Boys

I read with much interest the articles entitled "Catalogs and Advertising for the Boys," by Mr. Terry in the Aug. 14 issue and also by Mr. Brong in the Oct. 9 issue.

As a young lad I was running a 125-hp. engine in Aroostock County, Maine. The steam for the engine was supplied by three 1,000-sq.ft. boilers. After the plant had been in operation for some time, it became necessary to make alterations in the piping system, and I was instructed to make up a list of the pipe and fittings required for the job.

Before doing this, I wrote one of the oldest firms manufacturing pipe and fittings, requesting their catalog. Much to my surprise, however, instead of receiving the catalog, I got a letter instructing me to make my request under my company's official letterhead. This I was unable to do as the company never had any such paper that I knew of.

I have many times since been in a position to buy pipe and fittings or to recommend their purchase, but that particular firm has never received any of the business.

Biddeford, Me. HARRY H. GORDON.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Draft Losses in H. R. T. Boilers

In the operation of horizontal return-tubular boilers, what losses of draft occur between the smoke uptake and furnace space over the fire? A. B.

When horizontal return-tubular boilers are operated with sufficient draft for combustion of 20 to 25 lb. of coal per square foot of grate per hour, the draft available at different parts of the setting, expressed as a percentage of the draft at the stack side of the damper in the smoke uptake, is about 70 per cent in the front smoke connection, 48 per cent in the rear combustion chamber and 44 per cent in the furnace space over the fire. Thus, if the force of draft on the stack side of the smoke uptake is 0.6 in. of water, the drop of draft pressure between the furnace and smoke uptake should be $(0.70 - 0.44) \times 0.6 = 0.156$ in., and greater drop would indicate unusual obstruction of the tubes or boiler setting.

Absence of Counterbore in Duplex Pumps

In direct-acting duplex pumps, why are not the cylinders counterbored as in cylinders of steam engines? P. D.

In a reciprocating steam engine, where the piston is constrained to a constant length of stroke, the ends of the cylinder are counterbored so the piston may override the ends of the main bore and thus prevent the wear from forming a shoulder at each end of the stroke. In a duplex pump the exact length of stroke and portions of the cylinders over which the pistons travel vary with the speed, steam pressure, valve setting, amount of compression obtained and delivery pressure, and counterboring the steam cylinder would have to begin a sufficient distance outside of the exhaust passage for it to be sufficiently lapped by the piston to form a good seal for effecting compression. As in ordinary duplex pumps there is little probability of abrupt corners being formed from wear, counterboring the cylinders usually is omitted.

Relative Humidity

How is the relative humidity of the atmosphere estimated? L. H. K.

At every different temperature a cubic foot of atmospheric air is capable of holding a different weight of moisture in a condition of saturated vapor, and when that condition exists the humidity is 100 per cent. For instance, at 32 deg. F. one cubic foot of atmospheric air of 100 per cent humidity will hold 0.00376 grain of moisture; at 50 deg. F., 9.14 grains; at 60 deg. F., 13.138 grains; at 70 deg. F., 18.59 grains. If a sample of air at 70 deg. F. can be cooled to 50 deg. F. before the vapor content is condensed, this lower temperature is called the dew point. The moisture present would be just enough to cause saturation at 50 deg. F., namely 9.14 grains or $\frac{9.14 \times 100}{18.595} = 49$ per cent of the quantity of saturated vapor that could be held in suspension by air at 70 deg. F. Hence the relative humidity in the original state would be 49 per cent. The weight of saturated vapor that can be contained by a given volume of atmospheric air at different temperatures may be ascertained by inspection of humidity tables given in many works on physics and engineering, and the dew point may be obtained by some form of condensing hygrometer.

Temperature of Water Returns from Steam Mangles

We operate a number of mangles that are supplied with steam at 90 lb. gage pressure. The condensate is returned to the boiler at the temperature of 280 deg. F. What is the temperature of the condensate as discharged from the mangles? H. S. Y.

The condensate as discharged from the mangles would have the same temperature as the steam in the mangles. In ordinary operation there would be a drop below the supply pressure of at least three pounds below the pressure of the supply. If the pressure within the mangle is 87 lb. gage, the temperature of steam and of the water as discharged would be 329.3 deg. F. If the temperature in the discharge line going to the boiler is 280 deg. F., the difference, $329.3 - 280 = 49.3$ deg. F., is due to loss of heat from the discharge line, or part of the difference may be due to maintaining less than 87 lb. gage pressure in some of the mangles.

Pipe Surface Required for Heating Water

Using steam at 40 lb. gage pressure, what length of 1-in. wrought-iron pipe or of 1-in. outside diameter copper pipe would be required for coils in a closed tank to heat 500 gal. of water from 60 to 160 deg. F. per hour? W. N. S.

The rate of transfer of heat from steam coils to surrounding water varies per unit of surface per degree difference of temperature of the steam and water, with the temperature difference, the condition of the pipe surface and with the velocity of the water in its circulation over the heating surface. The pipe surface used in this manner soon becomes covered with a non-conducting film from corrosion or deposit of impurities in the water, and the transfer of heat is further retarded by bubbles of air or steam formed out of the water that adhere to the heating surfaces. The transfer of heat from clean iron pipe surfaces per square foot per hour per degree of difference of tem-

perature varies in quiet water from about 130 B.t.u. with a mean temperature difference of 50 deg. F. to about 300 B.t.u. for a temperature difference of 200 deg. F., and for clean copper coils the rate is between two and three times as much. However, the difference between iron and copper heating surfaces is much less when the surfaces have become coated with a film.

Some manufacturers allow steam-pipe heating surface for heating water on the basis of 100 B.t.u. per sq.ft. per degree difference, per hour, for iron pipe, and about 130 B.t.u. for copper pipe. In heating water from 60 to 160 deg. with pipe coils containing steam at 40 lb. gage or 287 deg. F., the mean temperature difference would be $287 - \left(\frac{160+60}{2}\right) = 177$ deg. F. On the basis stated, each square foot of iron pipe surface would yield $177 \times 100 = 17{,}700$ B.t.u. per hour, or of copper pipe surface $177 \times 130 = 23{,}010$ B.t.u. per hour, and one linear foot of 1-in. nominal inside diameter wrought-iron pipe would yield $17{,}700 \div 2.9 = 6{,}103$ B.t.u. per hour, or one linear foot of 1-in. actual outside diameter copper pipe would yield $17{,}700 \div \frac{3{,}1416}{12} = 4{,}634$ B.t.u. Each pound of water heated from 60 to 160 deg. F. would have to receive 100 B.t.u., and as 500 U. S. gallons would weigh $500 \times 8.33 = 4{,}165$ lb., heating that quantity of water would require $4{,}165 \times 100 = 416{,}500$ B.t.u., and to do the heating in one hour would require $416{,}500 \div 6{,}103 = 68.25$ lin.ft. of 1-in. iron pipe, or $416{,}500 \div 4{,}634 = 90$ lin.ft. of 1-in. o.d. copper pipe. If the quantity of water to be heated is 500 British gal., then the weight per gallon should be taken as 10 instead of 8.33 lb., requiring $68.25 \times 10 \div 8.33 = 82$ lin.ft. of 1-in. iron pipe or $90 \times 10 \div 8.33 = 108$ lin.ft. of 1-in. o.d. copper pipe.

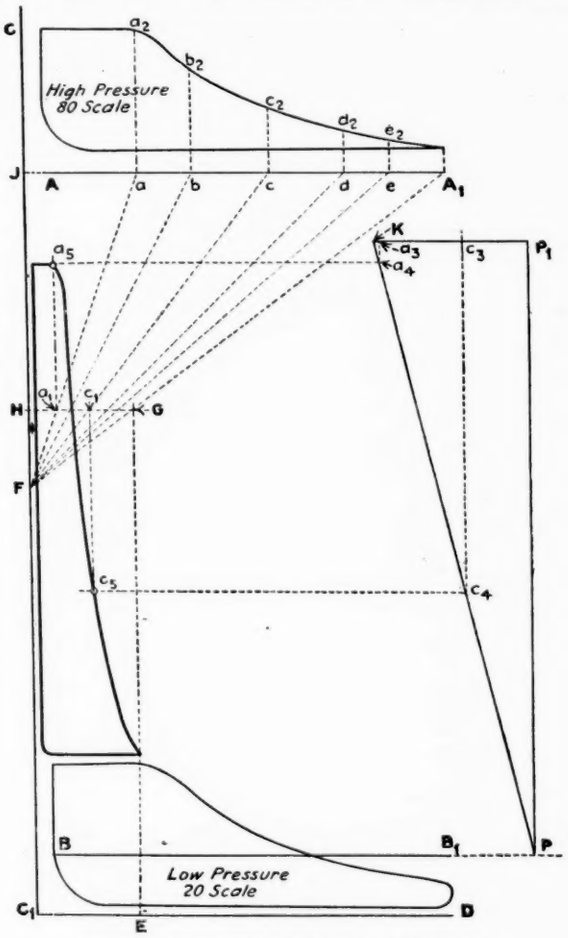
Combining High- and Low-Pressure Diagrams

How are the high-pressure and low-pressure indicator diagrams of a compound engine combined into a single diagram? R. N. C.

Suppose we have a compound engine with the low-pressure cylinder twice the diameter of the high-pressure cylinder, each with 5 per cent clearance, and that from this engine we obtained the high-pressure diagram with a spring scale 80 lb. per in. in the low-pressure diagram with a spring scale 20 lb. per in., shown in the illustration. To reduce the diagrams to the same scale of volumes, the high-pressure diagram including its clearance may be reduced to the scale of volume of the low-pressure cylinder and the pressure scale must be increased as though the diagram had been taken with a 20-lb. spring in the indicator.

Fix the high-pressure diagram above the low-pressure diagram with the atmosphere line $A\ A_1$ parallel to the atmosphere line $B\ B_1$ of the low-pressure diagram, each with clearance set off by the same vertical line $C\ C_1$. The actual relative volumes of the cylinder will be 1.05 to $1.05 \times 2 \times 2 = 1.05$ to 4.2. Then where the length of low-pressure diagram including clearance is $C_1\ D = 4.5$, set off $C_1\ E_1 = \frac{1.05}{4.2}$ of $4.5 = 1.05$ in. for the length of the high-pressure diagram reduced to the volume scale of the low-pressure diagram. To any point F in the clearance line, draw $A_1\ F$. Through E draw a perpendicular intersecting $F_1\ A$ at G, and through G draw the horizontal line $H\ G$. Then $H\ G = C\ E$, and lines drawn from points a, b, c, d, e, to F will divide $H\ G$ in proportion to the divisions of the line $J\ A_1$ so that, in the reduced volume diagram, a volume Ja will be represented by $H\ a_1$; volume $J\ c$ by $H\ c_1$, etc.

The scale of spring for the high-pressure diagram being 80, and of the low-pressure diagram 20, at any convenient scale set off the perpendicular $P\ P_1$ above the atmosphere line $B\ B_1$ of the low-pressure diagram, and at right angles, set off the horizontal line $P_1\ K$, $\frac{20}{80}$ or $\frac{1}{4}$ of $P\ P_1$. Then to locate a point on the new diagram to correspond with a point like c_2 vertically over c on



COMBINING INDICATOR DIAGRAMS OF COMPOUND ENGINE

the high-pressure diagram, lay off $P_1\ c_3 = c\ c_2$, drop the perpendicular $c_3\ c_4$ to intersect $K\ P$ at c_4. Next draw a horizontal line through c_4 and a vertical through c, in the line $H\ G$, and their point off intersection c_5 will be a point in the expansion line of the converted diagram to correspond with the point c_2 in the original high-pressure diagram.

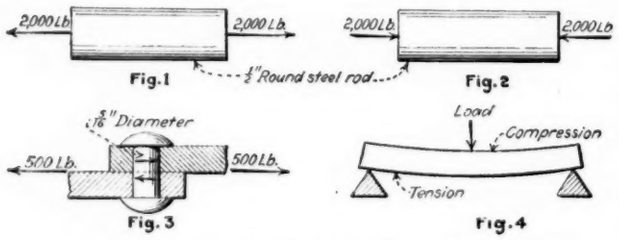
In the same manner lay off $P_1\ a_3 = a\ a_2$, drop perpendicular $a_3\ a_4$ and then a_5, which is the point of intersection of the perpendicular through a_4, and the horizontal through a_1, will locate the point corresponding to a_2. Thus locating a sufficient number of points, they can be connected into a complete diagram of the high-pressure cylinder, reduced to the pressure and volume scales of the low-pressure diagram; or, in a similar manner, the low-pressure diagram can be reduced to the scales of the high-pressure diagram.

Easy Lessons in Engineering

Stresses and Strains

While the power-plant engineer is not generally concerned with the deeper technicalities of the "mechanics of materials," he can often make practical use of an elementary knowledge of the subject.

The first thing to get straight is the difference between *stress* and *strain*, terms that are often confused. When external forces are applied to any object, balancing forces are set up within the material. These internal forces are called *stresses*. At the same time the size or shape of the body is always changed (although this change may be too small to be visible without instruments). These changes in size or shape are called



FIGS. 1-4. EXAMPLES OF TENSION, COMPRESSION, SHEAR AND BENDING

strains. It may be argued that strains cause stresses or that stresses cause strains, but such arguments are fruitless. The important thing to note is that the two always go together.

As the simplest example of stress and strain, take the case of a rod under tension, as shown in Fig. 1. This shows a round rod one inch in diameter with a pull of 2,000 lb. at each end[1]. The total tensile stress in the rod is simply 2,000 lb. This is independent of the dimensions.

To judge the importance of this stress in relation to the strength of the rod, we must compute the *unit stress;* that is, the stress per square inch of cross-section. The cross-section of the rod is a circle whose area is $(0.5)^2 \times 0.7854 = 0.196$ sq.in. A tensile stress of 2,000 lb. acting over an area of 0.196 sq.in. gives a unit stress of $2{,}000 \div 0.196 = 10{,}200$ lb. per square inch.

Suppose another rod of the same material had been tested and found to break under a tensile unit stress of 55,000 lb. per sq.in. Then, dividing 55,000 by 10,200, we find that the ultimate strength of the material is 5.4 times the load actually applied. This ratio is known as the *factor of safety*.

The tension stretches the rod a little, the amount being proportional to the length of the rod. The stretch is also proportional to the unit stress, as long as the unit stress does not exceed the elastic limit.

Instead of the ends of the rod being pulled apart as shown in Fig. 1, they might be pushed together as shown in Fig. 2, the forces here being 2,000 lb. as before. The total compressive stress is then 2,000 lb. and the compressive unit stress 10,200 lb. per square inch.

If the compressive strength of the material (that is, the compressive unit stress at which it crushes) is 58,000 lb. per sq.in., the factor of safety in compression is $58{,}000 \div 10{,}200 = 5.7$.

An important reservation should be made here. The total external compressive force divided by the cross-sectional area does not give the true unit stress in the rod if the rod is long enough to bend when the ends are pushed together. If bending occurs, the stresses are much more complicated and cannot be figured without the aid of special column formulas.

The third fundamental variety of stress is called *shear*. This is the principal stress in a piece of metal subjected to the action of a pair of shears. The shearing stress is the force tending to slide one layer of the metal over the next. This will be made clear by reference to Fig. 3, which shows two pieces of metal held together by a single ⅛-in. rivet. If forces are applied as shown, there is a shearing stress of 500 lb. tending to slide the top half of the rivet over the lower half. The cross-sectional area of this rivet is 0.0766 sq.in., so the shearing unit stress is $500 \div 0.0766 = 6{,}520$ lb. per sq.in. Taking the shearing strength of the rivet material at 40,000 lb. per sq.in., the factor of safety against shearing is $40{,}000 \div 6{,}520 = 6.14$. It should be noted that the joint as a whole might have a factor of safety less than this, since there are other ways, aside from the shearing of the rivet, in which it might fail. A riveted joint, like a chain, is as strong as its weakest link. The figuring of riveted joints will be the subject of a separate article.

When a beam is bent by a load, as shown in Fig. 4, there is a combination of shear tension and compression, the two latter being generally the more important. If the beam was originally straight, the concave side is under compression and the convex under tension, both of these stresses acting parallel with the axis of the beam. This follows because the convex side is longer than before bending, and the concave side shorter.

The figuring of beams is a subject of great interest, but one that we must pass by for lack of space. Where an operating engineer needs to erect a beam or column for some special purpose, he can usually select a suitable size and shape from the tables given in the general engineering handbooks or in the special structural handbooks issued by the steel companies.

[1] In many cases where a part is under tension, the pull appears, at first glance, to be applied at one end only. In such cases the support at the other end automatically exerts an equal and opposite pull.

How $250,000 Was Saved Per Year in Boiler-Plant Operation

AT THE Berkshire Hotel, Reading, Pa., the Philadelphia section of the Association of Iron and Steel Electrical Engineers held its regular monthly meeting on Saturday evening, Nov. 3. The meeting, in point of attendance and interest taken, was one of the most successful ever held by this section. Chairman W. H. Burr presided and there were about 300 members and guests present. In the afternoon members of the Association and their guests were taken by special trolley cars to the West Reading power plant of the Metropolitan Edison Co. and shown through the plant. The meeting was preceded by a dinner at the hotel, and the technical session was opened by an address by E. J. Poole, member of the Pennsylvania Chamber of Commerce. Mr. Poole, after reviewing the conditions in the steel and iron industry when most all materials were handled by hand, said that the work done by electricity is something that cannot be comprehended and it has done more to advance the iron and steel business than any other single factor.

Improvement in Steam Practices

A paper was presented on "Improvement in Steam Practice as Accomplished at Lukens Steel Company," by G. Donald Spackman, combustion engineer, Lukens Steel Co., Coatesville, Pa. Mr. Spackman told how it had been possible to realize a saving of $300,000 a year in the operation of the boiler plants at the Lukens Steel Co. The cost of making this saving possible was not over $50,000, which left a net saving of $250,000 the first year. Before the investigation was started which led to the improved conditions being realized, there were in use 38 horizontal return-tubular boilers, having an aggregate of 122,500 sq.ft. of heating surface, installed in four plants, and 20 water-tube boilers having an aggregate heating surface of 97,560 sq.ft. installed in three plants. It was found possible to carry the load on the water-tube boilers only, thus taking 38 boilers out of service, all of which were coal fired. Of the 20 boilers now in service only 4, having a total heating surface of 20,000 sq.ft., are coal fired with underfeed stokers, the other 16 being waste-heat boilers. In other words, it has been possible to take 86 per cent of the coal-fired boiler capacity out of service permanently and cut the coal consumption approximately 66 per cent for the same tonnage produced in the mills. For a given monthly production in 1920 the coal consumption by the boilers was 6,882 tons; for practically the same mill production in 1923 the coal burned was 2,279 tons.

The speaker emphasized the importance of instruments in the boiler room and the necessity of keeping them in good operating condition. In the stoker-fired boiler plant there were many instruments installed, but all of them had been allowed to fall into a state where they were not operative. One of the first things done to improve operation was to put these instruments in condition. Since then they have been giving excellent satisfaction. In this plant there was no way provided for weighing the coal, and this was solved by attaching a revolution counter to each of the stoker shafts. This method was found accurate to within less than 1 per cent, over a period during which 75,000 tons of coal was burned.

To get the operators to take an interest in the plant's performance, a bonus system was introduced which has produced the desired effects. This system is based on the percentage of CO_2 maintained in the flue gases and starts at 8 per cent and works upward to 14 per cent which is the desired figure. A penalty is involved if the CO_2 is allowed to go above 14 per cent, as it is believed that this value is about as high as can be obtained on stoker-fired boilers without getting CO in the gases.

A recording V-notch meter is installed on the blowdown of the boilers to detect leaks in the blowdown valves. A second recorder has been installed, arranged so that the flow record is magnified 10 times. In this way a very small leak will show up on the recorder. Careful attention is given to leaks in all piping valves, traps, etc., and it is one man's job to look after leaks, make repairs where he can and notify the proper authorities when the leak cannot be repaired without a shutdown of some steam or water line. When the work was started, the boiler setting and baffles were in a poor state of repair. These on all boilers, both stoker-fired and waste-heat, are now carefully watched and maintained as tight as possible. Up to 1920 the plant was given very little attention, but it is now operated under the direction of skilled men whose business it is to see that high economy is obtained.

Not only is there co-operation among the boiler-room operators, but also between these men and the rolling-mill crews. When an engine is to be started in the mill, the boiler-room operators are notified in advance so that the boilers can be speeded up and ready to meet the demand. This has resulted in making it possible in many cases to carry the increased load on two stoker-fired boilers where three would have been required. The speaker laid great stress on the importance of the daily log sheet and maintenance and inspection reports.

Discussing Mr. Spackman's Paper

In discussing the paper, E. M. Gilbert called attention to what he considered the chief reason for the improvement in operation; namely, the concentration of the plant in one place where the equipment could be operated directly under competent men. The speaker said that although there was no such thing as an automatic stoker, the mechanical stoker did make it possible for the boiler-room men to give more attention to the plant's operation. He said that in the new plant his company was building, a steam pressure of 350 lb. and 220 deg. of superheat were going to be used, which would give a total steam temperature of about 700 deg. With such high temperatures economizers become desirable. Instead of putting all the heating surface in the boiler, this is reduced and part of it is put into an economizer with a considerable improvement in efficiency. Pulverized coal is to be used in the new plant. One of the reasons for doing this is that it provides a means of stabilizing the price of coal at the plant. Provisions are being made to pulverize any kind of fuel, even to river anthracite which can be pumped out of the river at the plant. Another reason for using pulverized coal is the high boiler efficiency, 86 per cent being possible for the new plant according to the guarantees given on the equipment. The speaker emphasized the importance of centralizing the control of the boiler plant.

A. J. Standing said that boiler-plant operation had emerged from the dirty job of the past into one of first importance in power-plant performance. The paper dealt with facts that can be applied to other plants.

P. A. Vanderwaart said that there were two lessons to be learned from the paper: First, obtain good engineering advice in designing and operating the plant; second, obtain the proper class of employees in the plant.

E. D. Sibley emphasized the importance of all the operators being familiar with the load on the system. In his company's plant a signal system is used to notify the boiler-room operators as well as those at the switchboard and in the turbine room when a unit is to be taken off or put on the line, so that proper preparation can be made in the boiler rooms to meet the new conditions. The human element in the boiler room was in Mr. Sibley's opinion one of the most important factors in obtaining high efficiency in plant operation. Plants may be designed for high economy, but unless the operators are qualified to get results they will not be obtained.

J. A. Kinney told of his experiences trying to pulverize anthracite river coal. These experiments had not been successful on account of the excessive maintenance costs. Mills that were entirely satisfactory on bituminous coal were worn out in two or three days when used on river coal.

J. A. Powell said that too much effort cannot be spent to maintain CO_2 as high as practical, the maximum percentage being determined by the type of fuel-burning apparatus, fuel and brickwork maintenance. With stokers it is possible to obtain above 13 per cent but when considering efficiency and brickwork maintenance, this is about as high as considered advisable. However, with pulverized fuel from 15 to 16 per cent is easily obtainable without excessive brick maintenance.

Tests recently conducted by the Duquesne Light Co., of Pittsburgh, on a boiler burning pulverized fuel show the effect of CO_2 on boiler efficiency and capacity. We have theorized a great deal on this subject, but it has never been possible before to operate a boiler at will with any CO_2 and any capacity. Complete efficiency curves were obtained from minimum to maximum loads at 8, 10, 12, 14 and 16 per cent CO_2. When operating the boiler at 200 per cent of rating, the following was obtained:

CO_2 Per Cent	Boiler Efficiency Per Cent
8	75.5
12	79.5
16	81.5

At a constant efficiency of 75 per cent the rating with 1 in. available draft was as follows:

CO_2 Per Cent	Boiler Rating Per Cent
8	202
12	262
16	302

From the foregoing it can be seen that low CO_2 means not only poor efficiency, but also reduced capacity on the boiler plant, an increase in CO_2 from 8 to 12 per cent meaning 60 per cent boiler rating addition and from 12 to 16 per cent, 40 per cent of boiler rating addition. With high CO_2 extreme care must be taken to see that CO does not exist, as the loss from this is very high; 1 per cent CO results in approximately 6 to 7 per cent loss in efficiency. Electrical CO_2 and CO instruments are now being exploited, and this instrument appears to have a future, particularly in the operation of pulverized-fuel boilers.

Today in central stations a great deal of thought is given to heating feed water in the most economical way. Steam is extracted from the main turbine in various stages instead of using non-condensing turbines for auxiliaries, and in this way the temperature of the feed water is raised in steps to the desired final temperature. With this scheme steam that has done the most useful work in the plant is used to give up its latent heat and thereby more economy obtained. To use such means, however, requires motor-driven auxiliaries.

If 1,000 lb. of steam is withdrawn from the main turbine at a temperature of approximately 150 deg., it is only necessary to add 250 lb. at the throttle to maintain the same load on the turbine, and at approximately 212 deg. atmospheric pressure, if 1,000 lb. is extracted it is necessary to add 500 lb. at the throttle.

Assuming that a given quantity of feed water is raised to a final temperature of 212 deg., it will be found that with motor-driven auxiliaries only one-half as much steam for auxiliaries will be required as when turbine-driven; in other words, with the old type of plant using turbine-driven auxiliaries it was necessary for the boilers to evaporate approximately 13 per cent more steam than used by the main turbine, but with all motorized auxiliaries and steam extracted from the main turbine for feed-water heating, this is reduced to 6.5 per cent, or a net saving of 6.5 per cent on the coal pile.

Motor-Operated Centrifugal Pumps in Steel Plants*

By B. A. CORNWELL

CENTRIFUGAL pumps are especially suited for handling large quantities of water, and in many steel plants this type of pump has been adapted for supplying water under low heads for blast furnaces, condensers, cooling-water systems, etc. The general laws governing the action of all centrifugal pumps are:

1. The head varies as the square of the speed.
2. The quantity of water pumped varies directly as the speed.
3. The power required to drive the pump varies as the cube of the speed.

Owing to the construction and the characteristics of this type of pump, the starting requirements are not heavy, as the starting torque rarely ever exceeds 30 per cent of the full-load torque. In Fig. 1, with the discharge valve open during the starting period, curve *A* shows how the torque will increase with speed. If the discharge valve is closed, the torque at full speed will seldom exceed 60 per cent full-load torque—this is shown in curve *B*.

With a centrifugal pump, decreasing the head pumped against will increase the load on the motor. This seems paradoxical, but many motors have been burned out because the user calculated that if a motor would pump a certain quantity of water against a head of 40 ft., it would have less load at a head of 30 ft. As a matter of fact the design of this type of pump is such that it will raise considerably more than four-thirds the amount of water at 30 ft. that it did at 40 ft. head, with the result that the motor is overloaded. In this respect the centrifugal pump is exactly opposite to the plunger or reciprocating pump, which, being positive in its action, increases its load with the increase of head and vice versa.

The performance and operation of typical centrifugal pumps as used in steel plants can best be seen by referring to the characteristic curves shown in Figs. 2 and 3, obtained from actual tests recently made on a 1,000-hp. 6,600-volt wound-rotor induction motor driving a 25,000,000-gal. centrifugal pump. This pump is of the single-stage double-suction type, with bottom suction, to operate against a total head of 165 ft.

TEST DATA ON 25,000,000-GAL. PUMP DRIVEN BY 1,000-H.P. INDUCTION MOTOR

Gallons Per Day	Hp. Input to Pump	Total Head Feet	Per Cent Efficiency Pump	Motor
10,000,000	700	210	52.5	91.8
15,000,000	825	205	64.5	92.6
20,000,000	910	196	74.0	93.0
25,000,000	995	183	81.0	93.2
30,000,000	1,030	165	84.0	93.2

The data and test results obtained are shown in the table. The motor driving this pump is designed for a temperature rise of 40 deg. C., with full load for 24 hours and a temperature rise of 55 deg. with 125 per cent load for two hours, immediately following a full-load run of 24 hours.

With the discharge valve closed the efficiency is zero, since no useful work is being done. The horsepower required under this condition is consumed in friction and dissipates itself as heat, with the result that an electrically driven pump of this type cannot be operated with its discharge valve closed for more than fifteen or twenty minutes without overheating. As soon as the discharge valve is opened, the capacity increases and the efficiency increases until it reaches a maximum of 30,000,000 gallons per day at an efficiency of 84 per cent. This particular pump has been in operation since 1918 and is still capable of delivering the same capacity as obtained five years ago, which is in excess of that guaranteed. In Fig. 2 the curves show that the power required to drive a centrifugal pump will vary directly with the product of the capacity and the head; for

*Abstract from a paper presented at the 17th Annual Convention, Association of Iron and Steel Electrical Engineers, held in Buffalo, N. Y., Sept. 24 to 28, 1923.

†Electrical Engineer, Carnegie Steel Co., Youngstown, Ohio.

example, capacity equals 25,000,000 per day or 17,500 gal. per min., total head equals 183 ft., pump efficiency equals 81.1 per cent.

The brake horsepower then $= \frac{Gal.\ per\ min. \times Head}{3{,}960 \times Efficiency} = \frac{17{,}500 \times 183}{3{,}960 \times 0.811} = 997$ input to the pump.

In order to make a comparison of the cost of the electric power consumed by this 1,000-hp. motor-driven pump with a

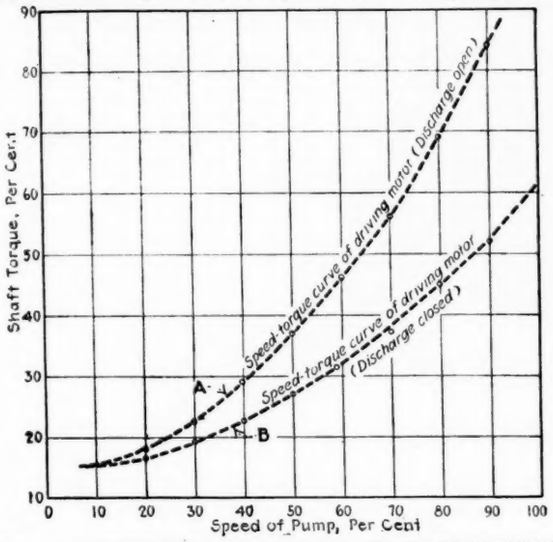

Shaft Torque, Per Cent
Speed of Pump, Per Cent
Speed-torque curve of driving motor (Discharge open)
Speed-torque curve of driving motor (Discharge closed)
A
B

FIG. 1—SPEED-TORQUE CURVES OF CENTRIFUGAL PUMP DURING STARTING

steam turbine driving this same pump on the same service, the operating cost per kilowatt-hour at the motor and the cost per pound of steam at the supposed turbine must be obtained. The average cost per kilowatt-hour for the electric power in the plant where this pump is operating is

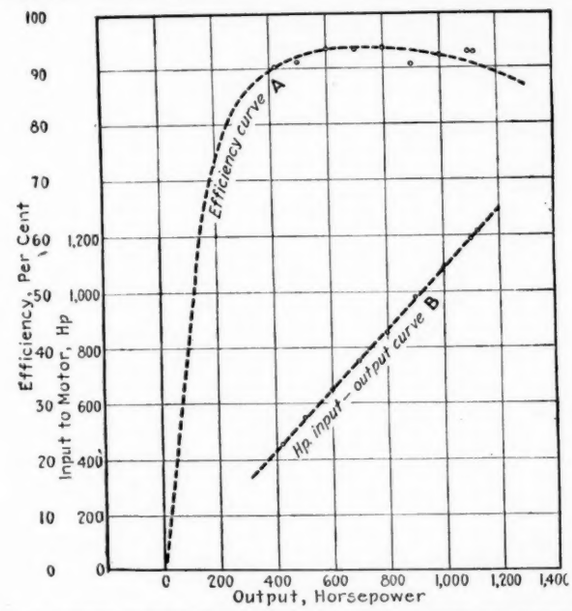


FIG. 2—TEST CURVES OF WOUND-ROTOR MOTOR DRIVEN CENTRIFUGAL PUMP

$0.00355—the generating station being equipped with blast-furnace gas engines.

Allowing a 2 per cent loss in the 6,600-volt line to the motor and taking the station cost of power at $0.00355 per kw.-hr. an average cost of power at the motor of $0.0036 per kw.-hr. is obtained. The test results showed this pump to have its maximum efficiency at 725 r.p.m. when delivering water at the rate of 30,000,000 gal. per day against a head of 163 ft. Under these conditions the input to the motor was 828 kw., or 828 kw.-hr. per hour. The cost per hour equals 828 × $0.0036 = $2.98 for electric power when delivering water at the rate of 1,250,000 gal. per hour, or the cost of pumping 1,000 gal. of water per hour will be $\frac{2.98}{1{,}250} = \$0.00238$.

The operating cost for steam power delivered to a supposed turbine driving this same pump on the same service is arrived at as follows:

Capacity, 30,000,000 gal per day at 165-ft. head, steam produced at 250 lb. per sq.in. and 150 deg. F superheat. Assume steam cost at $0.30 per 1,000 lb. From Fig. 3 the input to the pump is 1,030 horsepower.

Assume the steam consumption of the turbine and gears to be 10.5 lb. per b.hp.-hr. The steam to the turbine then equals $1{,}030 \times 10.5 \times \frac{165}{163} = 10{,}925$ lb. per hr. The steam to condensers and auxiliaries equals 430 lb. per hr., or a total of 10,925 + 430 = 11,355 lb. per hour.

Assume that a short steam line is used with a 3-in. covering and that the steam loss in the line amounts to 3 per

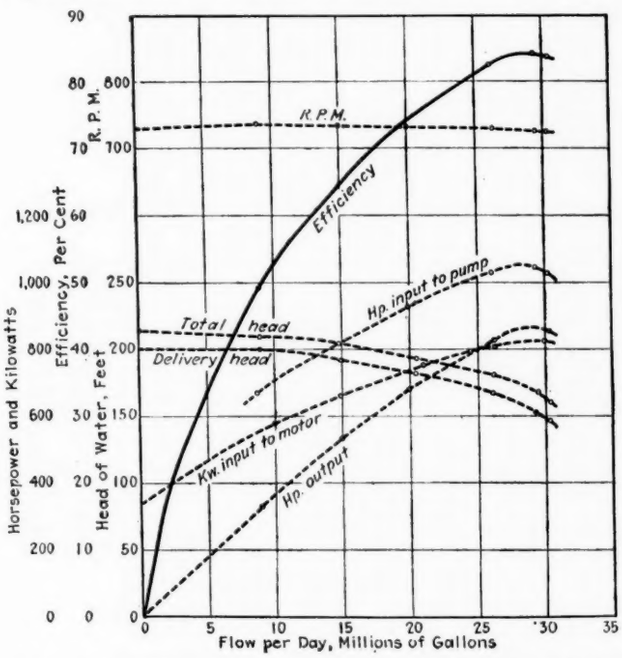


FIG. 3—CURVES FOR 1,000-HP. 6,600-VOLT MOTOR DRIVING 25,000,000-GAL. CENTRIFUGAL PUMP

cent, then the cost of steam at the turbine per hour will be $\frac{11{,}355}{0.97 \times 1{,}000} \times \$0.30 = \$3.51$ when delivering water at the rate of 1,250,000 gal. per hr., or the cost of pumping 1,000 gal. per hr. will be $3.51 ÷ 1,250 = $0.00288.

In the comparison the ratio $\frac{165}{163}$ is due to the greater head on account of the loss through the waterworks condenser. Also in case of the electric power being produced by a steam turbo-generator, the operating cost of the electric power to the motor-driven pump will be slightly higher. In case lower pressure saturated steam is used to operate the turbine-driven pump, or if a good vacuum cannot be maintained the operating cost of the steam pump will increase greatly.

The comparative initial costs of the 1,000-hp. electric motor and the turbine-driven installations including starters or condensers and auxiliaries, but exclusive of buildings, wiring or piping, which would vary greatly, depending upon local conditions, are as follows:

Induction motor driving pumping unit	$15,400.00
Synchronous motor driving pumping unit	15,800.00
Steam turbine driving pumping unit	38,000.00

However, in this comparison, the motor driving the motor-driven pumping unit should be charged with its part of the power-station costs exclusive of boilers in case turbo-generators are used, or in any case power is produced by gas-engine driven generators, the motor-driven unit should be charged with its proportional part of the power-station costs and the turbine-driven pump with its part of the boiler-house cost as follows:

A 15,000-kw. turbine generating station exclusive of boiler house would cost approximately $53 per kw. of capacity.

A 21,000-kw. gas-engine driven generating station would cost approximately $190 per kw. of capacity.

A boiler house for boilers to produce 300,000 lb. of steam per hour output would cost approximately $2,600 per 1,000 lb. of steam per hour capacity. All of the figures given have been estimated and do not include any spare equipment.

Growth of the Electric Light and Power Industry*

By Charles H. Bromley†

The purpose of this paper is chiefly to present data on which to base action to the end that the Association may rightly meet the great economic changes in supplying the community's power and lighting needs by the development of the electric light and power industry. A great, and for this Association, a significant change has come in the business of power generation and transmission. This change is the result of the application of correct and advanced engineering principles to the art of power production and distribution. The central power system is one of the greatest factors in the advancement of our industrial civilization. It is based upon sound economic principles and is destined to grow in the future as it has in the past. Though only about thirty-five years old, actively at least, the electrical industry is now the second greatest in America, being capitalized at more than $14,000,000,000. Steam railroads alone surpass it with $18,000,000,000.

The following data are from numerous sources, including the United States Bureau of the Census, National Electric Light Association, *Electrical World* and other publications. These data are by no means complete, but they are sufficient to form the groundwork for more thorough study in their relation to the future policies of the N. A. S. E.

Energy Generated by Central Stations, Exclusive of Railway Plants

Year	Kw.-Hr. Output
1887	175,000,000
1892	300,000,000
1902	2,337,000,000
1912	11,569,109,000
1916	21,230,000,000
1919	35,028,000,000
1922	43,290,000,000
1923 (estimated)	66,000,000,000

Year	Output for Lighting, Kw.-Hr.	Output for Power in Industries, Kw.-Hr.
1882	121,000,000	11,000,000
1912	2,752,000,000	3,254,000,000
1922	8,000,000,000	22,320,000,000

Note the pronounced change in the consumption for power contrasted with that for light between 1882 and today.

Operating Companies

No. of companies in 1922	5,897
No. of municipal plants, 1922	1,992
(417 of these purchase current)	
No. of hydro-electric plants	1,439

Output of Companies

In 1922 there were six systems with a total annual output of over 1,000,000,000 kw-hr.

In 1922 about 70 per cent of the total output was distributed by 87 systems.

In 1922 the largest output was by Niagara Falls Power Co., with 2,252,249,000 kw.-hr.

*From a paper before the 1923 Convention, National Association Stationary Engineers, Buffalo, N. Y.

†Chairman National Educational Committee, N. A. S. E.

Maximum Peak Load

This held by Commonwealth Edison Co. in 1922, 600,000 kilowatts.

Greatest monthly output in March, 1922, with 5,690,000,000 kw.-hr. for the whole industry.

Geographical Distribution

Ten states produced 84.77 per cent of total electrical energy output in 1922.

State	Per Cent of Total Output for United States
New York	15.57
Pennsylvania	9.50
California	9.19
Illinois	7.31

Center Activity Electric Light & Power

In 1882 this center was New York City; in 1923 it is 116 miles south of Chicago, Ill.

Output by 1935

At present rate, and based upon surveys output in 1935 will be 150,000,000,000 kw.-hr.

Electrical Energy Costs Compared with Cost of Living

Increase in cost of living since 1913 (U. S. Dept. Labor) 68.8. During the same period electrical energy costs decreased 2.4 per cent. This is a striking example of the economic soundness of the engineering and business principles used by the industry.

Additions and Extensions in 1923—Values

Steam-electric plants	1,987,000 Kw.
Steam-electric plants, value	$209,417,000
Hydro-electric plants, value	$74,396,000
Total value all extensions, including transmission systems	$602,000,000

Capitalization of Electric and Other Industries (1923)

Electrical	$14,500,000,000
Iron and steel	9,113,000,000
Chemicals and allied Products	7,649,000,000
Mines, quarries and wells	7,109,000,000
Textiles	6,273,000,000
Food	4,939,000,000
Steam Railroads	18,000,000,000

Annual Income of light and power branch of the electrical industry in 1922 was $1,084,000,000.

Stock and Bond Issue (1922): Total value, $750,000,000.

Industrial Users of Electric Power (1920)

Industry	Kw.-Hr.
Iron and Steel	8,115,000,000
Chemical	6,074,000,000
Coal	2,500,000,000

Proportion Hydro-Electric Output

	Per Cent of Total Energy Generated
1919	37.5
1920	37.1
1921	36.5
1922	36.1

Rank of States in Hydro-Electric Power Production

State	Per Cent of Total Hydro-Electric Energy Produced
California	21.95
New York	17.15
Washington	7.03
Montana	5.68

Water Power, Potential and Developed (1922)

Potential	30,500,000 hp.
Developed	9,700,000 hp.

Motor Load Carried by Central Stations

In 1904 more than 72 per cent of the total electric-motor load in the United States was carried by private generating plants. In 1923 only 39 per cent is carried by private plants.

Total rating of motors in manufacturing plants, mines, quarries, and wells (1922) was 8,230,293 hp.

Private Generated and Purchased Energy

Energy purchased by manufacturing plants, mines, quarries and wells (1920), 19,040,000,000 kw.-hr.

Energy generated by private plants in some industries in 1920, 14,242,000,000 kw.-hr.

News in the Field of Power

Coal Commission Says Profits Are Increasing and People Pay for Speculation in Coal Lands

Advises Differential Taxation—Publicity of Accounts to Begin at Once—Use of Substitutes

THE principal facts found by the United States Coal Commission in its investigation, "Investments and Profits in Anthracite Mining," are:

No average figure either of margin per ton or per cent return on investment can fairly represent the profit in anthracite mining. Because of great inequalities in cost and in selling arrangements some operators make very large profits and others very small profits. The margins per ton between cost and sales realization in ordinary times range from less than nothing to over $2 a ton. The per cent return on book value of investment in coal ranges all the way from a loss to 138 per cent (one independent operator, year 1917).

There has been a very large increment in value so that the lands are now worth on the market more than they used to be, although a third of the coal is gone.

Since 1913 a further huge increment in market value has accrued to the owners of the property. A committee of engineers appointed by us estimates the present market value of mines and mineral as $989,000,000. The book values, allowing for companies and holdings not examined by the accountants, are in the neighborhood of $600,000,000. This indicates a further increment of hundreds of millions of dollars, inuring to the owners, if the engineers' estimates based on earnings are accepted.

The profits are increasing. Total net income is increasing, dividends are increasing, and surpluses are increasing—earned surpluses as well as surplus arising through revaluations. The margin per ton is increasing.

Labor cost and other costs also show a large increase over pre-war figures, but the increase in price has been such that the operators' margin since the war has on the whole been about the same percentage of the sales realization that it used to be.

The practice of many companies of carrying large reserves of coal lands held for future use, adds to costs through taxation and conceals profits. The largest of the railroad coal companies—the Philadelphia & Reading, a high operating cost company—is overburdened with reserves sufficient to last more than two hundred years. On this total investment it has shown an inadequate return, the loss having been made up by the large earnings of the affiliated railroad. Freed from the carrying charge of this excess reserve, it could make an adequate return. Taxes and interest on coal not to be mined within forty years are not properly chargeable to present operations. Speculation in land should not be confused with mining coal.

The Committee make the following specific recommendations for the attention of the industry, the states and the federal government:

In order to permit the public as a whole to share in the good fortune of the low-cost, high-profit operator, we recommend that differential taxation shall be applied to differential advantage. Sweeping horizontal cuts cannot be made in present mine prices and margins without serious injury to many high-cost operators, whose output is needed. Taxes falling lightly on the low-profit operator and more heavily on the high-profit operator in proportion to his ability to pay will benefit the consumer indirectly through lightening the tax burden elsewhere and will accomplish this without raising prices.

To protect the public against unjustified increases in price, we recommend complete publicity of accounts through a federal agency with power to compel reports and to prescribe the form of accounts.

Because of the large increase in operators' margins per ton since the strike of 1922 and the possibility of further increases in price as a result of the recent settlement, we believe that such current publicity as to costs, margins and profits should begin at once. Unless the public is protected by publicity of accounts, we are apprehensive that the concentrated control of the industry may take indefensible profits.

The consumer has in his own hands a measure of protection against unreasonable profits. We recommend to consumers the use of substitute fuels.

Pit River No. 3 Contracts Awarded

The Pacific Gas & Electric Co. has awarded to the Pelton Water Wheel Co. the contract for the building of three 33,000-hp. vertical reaction-type turbines, designated to operate under a static head of 313 ft. and an average effective head of 280 ft., for their Pit River No. 3 plant. One of the turbines will be equipped with rubber seal rings, and if the test of service shows materially better results, rings of this type will be installed in the others.

The contract includes, besides the main units, the governors, oil-pumping sets and other accessory apparatus, as well as three 108-in. butterfly valves and an impulse wheel for operating a spare exciter set.

Judge Gary Speaks of American Business with Optimism

Judge Gary, in his speech before the American Iron and Steel Institute on Oct. 25, at New York City, spoke of the attitude of the Washington Administration concerning the present trend of business and quoted an official of the Administration as follows:

"The impression in Washington seems to be that industry throughout the country is proceeding on a commendably conservative basis, with avoidance, so far as possible, of unnecessary advances in prices or avoidable expansions which would engender keen competition for labor. With a continuance of this general attitude it is felt that business should continue generally good for the remainder of this year. While there is reticence about making prophecies for the future, the general opinion seems to be that if this attitude continues, there can be reasonable assurance of a projection of generally satisfactory business conditions at least well into next year." It is believed these statements represent the mind of President Coolidge.

For the calendar year the iron and steel industry will show considerable profit, though not as much as the capital invested should produce. The new orders are not up to productive capacity, but, together with those heretofore accumulated, have resulted in large shipments. In some lines the demand for immediate consumption has been and still is in excess of the ability to supply.

It may be stated with confidence that the outlook is good. Inquiries for iron and steel are unusually large, many of them urgent. Purchases for railroad and general building purposes, for oil development and production, for canning purposes, for the automobile trade and many other lines are now very large as a total and from appearances may be expected to increase materially in volume during the next six months, unless something unforeseen and unwarranted shall be precipitated.

The actual purchasing necessities of our commodities are very great at present, and there is plenty of money to pay for whatever is needed. It is up to business management in every line to take advantage of the opportunities offered. Let us have faith in the future and do our part, proceeding always with good judgment, prudence and within the limits of our resources, but steadily forward toward the goal of the prosperity which we know is ahead and will be greater than ever before.

Giant Conservatory for Community Heating Proposed

Samuel R. Lewis, of Chicago, Ill., put forth an exceedingly novel idea in a paper called "Group Heating of Buildings," which he presented at the Illinois Chapter of the American Society of Heating and Ventilating Engineers at its convention at Chicago recently.

Briefly told, the scheme would mean the erection of a lofty building with properly oriented skylights that would cover over a whole city block or a similar prescribed area, the structure to be built of the highest reasonable grade of construction possible, and the structures beneath and within the lightest of shells, for privacy only.

If the enclosure is lofty, no mechanical ventilation would be required, as the difference in temperature between the enclosure and outdoors will cause a rapid air change. Dust, temperature, humidity and even air motion can be controlled by artificial showers of rain whenever these are needed from sprayheads in the roof.

The canyons of streets and alleys between our modern city buildings are exceedingly inefficient and wasteful from every viewpoint. If they are roofed over with glass immense saving of coal will be effected. Less labor would be required to clean the glass than is now used to clean windows and streets. Flying bridges here and there between buildings would save street congestion and much elevator service. Snow-handling problems would be simplified because it would be removed without interference with traffic.

Mr. Lewis has worked the scheme out in detail. Costs of construction, costs of heating, in fact every part of the intriguing dream has been thought of.

Hoover Tells Bankers About Importance of Power Projects for Investments

Says That the Northeastern Part of the United States Lags Behind in Power Developments

MR. HOOVER, in speaking at the banquet of the Investment Bankers Association, held Oct. 31, at Washington, "from the engineering point of view," made many clear and pertinent statements which, briefly summarized, are as follows:

The function of the investment banker is to find the money for the advancing equipment of the nation. As science advances, it is the duty of the engineer to lead its promises up to the investment banker. . . . I wish to suggest to you one of the new fields, or an old field in which there has been a great advancement in the past. and one in which you will be called upon for even greater effort. I refer to the great discoveries in the transmission of electrical power, the great perfection that has been produced by our engineers in the production of power and in the great centralization of plants. It has opened for us a new era in the production and distribution of power. While in the last decade it has multiplied our electrical equipment by ten, I am convinced it is going to be multiplied by ten in the next few years. It will produce great economies in the distribution of the load as between industries, as between seasons and between hours of the day. It will reduce our reserves and equipment. It now makes possible the generation of power in great centralized plants. It will in fact, reduce the cost of the production of power by figures of which we have not dreamed.

The Northeastern part of the United States alone has well demonstrated that fact. An investment of a billion and a quarter dollars means a saving of more than $500,000 annually in operating cost. We should make a saving of 50,000 tons in the consumption of coal.

It is true that some parts of our country have made great advances in this direction. There is a continuous interconnected power system, with the exception of one gap, between Seattle and San Diego. In the northeastern part of the United States such an advance has lagged far behind both the South and the West.

Our power development has taken place largely since the regulation of public utilities. Through that regulation and through the better understanding of the investment banker, through the greater skill of the engineers, there has been a more reliable return to the investor in these than from any other form of our national enterprise. You need have no fear that its future development will not justify your activity.

Investment banking is not my profession, but the investment banker is not a stranger to me. As I review some twenty-five years of incarnation as an engineer, it seems to me that a large part of it was occupied in arguments with the investment banker. As these arguments come back to me, they remind me of two main themes: Trying to explain where investment left off and where the speculation began; trying to convince him that public necessity and the advance of industry, good morals and his own pocketbook required him to find more money if he would save the gilt-edge investment that he had already made. You have a responsibility in the guardianship of our national interests in the conduct of capital.

Now in these matters of responsibility in our business world we approach a problem that goes to the root of our whole social life; that is, that we have to preserve the initiative and the vigor and the orginality of the individual American and at the same time carry on this great social conflex of political life. The solution does not lie in legislation and in government, but it does lie in an enlarged sense of the responsibility of the individual to his fellow members of society.

The building up of these responsibilities through the standards set by such institutions as yours is a direct contribution to the greatest problem that we have to meet this day.

Coal Emergency Bill Will Be Introduced in Next Congress

A bill will be introduced early in the next session of Congress, according to Representative W. J. Graham, of Illinois, that will give the President specific authority to take over the coal mines of the nation in the event of an emergency.

Public Works Department Being Studied

The President and the Cabinet are giving intensive study to the departments reorganization plan. While no announcement of such revisions in the Brown plan is likely to be made until it is transmitted to Congress, along with a Presidential message on the subject, it is thought that the proposal to combine the War and Navy Departments has been abandoned. It also is understood the Secretary of War has been convinced that the activities dealing with public works should be grouped in a single department.

Employment Falling Off but Wages Continue High

The National Industries Conference Board says that due to peculiar economic conditions in the United States there is a downward tendency in industrial work, but that the pay envelopes have 39 per cent more purchasing power than before the war. Average weekly earings of all wage-earners, which stood at $26.66 in July, fell off slightly or to $26.59, in August. With the exception of the male skilled group employment in August, 1923, was lower than in any month of 1923.

New England Holds Power Show

Engineers of New England were afforded an opportunity to inspect an interesting line of power-plant appliances at the Power Show, held at the Mechanics' Building, Boston, Mass., Oct. 29 to Nov. 3, under the auspices of the New England Association of Commercial Engineers and in connection with the International Textile Exposition. It has become a custom to have this exhibit bi-annually. Every one of the one hundred booths allotted to the power section were occupied, and although there was little radically new to be seen, the exhibits nevertheless included many refinements in design and were comprehensive in character.

Friday was designated as engineers' day and there was a large attendance from among the memberships of local engineering societies and local sections of national societies. In the evening, under the auspices of the New England Association of Commercial Engineers, with President Henry H. Lynch in the chair, an interesting program was presented including addresses by Howard Coonley, president of the Boston Chamber of Commerce, Frederick M. Gibson, president of the Plant Engineers' Club,

Frank M. Gumby, president of the Boston Society of Civil Engineers, James W. H. Myrick, treasurer of the New England Association of Commercial Engineers and John A. Stevens the well-known consulting engineer, of Lowell.

Power Exposition to Award Certificates of Merit

The management of the National Exposition of Power and Mechanical Engineering, which is to be held in the Grand Central Palace, New York City, Dec. 3-8, has arranged to award a certificate of merit to exhibitors who arrange their exhibits effectively.

Engineers attending the annual meetings of the American Society of Mechanical Engineers and the National Society of Refrigerating Engineers Dec. 3-6 will be able to visit the exposition during the afternoons and evenings.

Unique Cross Compound Geared House Turbines

Three cross-compound direct-current geared house turbines are being constructed by the De Laval Steam Turbine Co. for the Trenton Channel Plant of the Detroit Edison Co. The turbine ends will develop 8,500 hp. The 250-volt direct-current generators operate at 360 r.p.m. Geared to these are cross-compound high- and low-pressure turbine elements, operating at 4,000 and 3,000 r.p.m. respectively, with 375 lb., 700 deg. F. steam. Each house turbine is designed for a normal load of 4,000 kw., being capable of carrying 6,000 kw. at maximum overload.

Skinner and Osgood A. I. E. E. Presidential Nominees

C. E. Skinner and Farley Osgood have both been placed in nomination by petition for president of the American Institute of Electrical Engineers.

Mr. Skinner is a native of Ohio, born in 1865, and is a graduate of the Ohio State University. He had been with the Westinghouse organization ever since graduation, and his record there is one of continuous accomplishment. He is a fellow of the A.I.E.E. and has represented the society abroad and in various councils and committees in this country. He was a manager of the A.I.E.E. 1915-19 and vice-president 1919-20.

Mr. Osgood is best known as an operating man and has been for the last six years vice-president and general manager of the Public Service Electric Co. of New Jersey. He was born in Boston in 1874 and graduated from the Massachusetts Institute of Technology in 1897. He has served as manager of the A.I.E.E. from 1911-14 and vice-president 1914-16.

According to the Institute procedure the membership at large will vote on nominations next spring.

Obstacle to Completion of Detroit Municipal Plant Removed

The recent election resulted favorably with regard to the amendment permitting Detroit to extend its debt limit. It was the uncertainty as to the outcome of this that temporarily held up progress on the Detroit municipal plant. Now that the issue has been settled, it is likely that the work will be pushed to early completion.

Water-Power Projects

Priest Rapids Project—The Washington Development and Irrigation Co. has made formal application to the Federal Power Commission for a license covering its 350,000-hp. project at Priest Rapids. The company has complied with the conditions of the preliminary permit, which was granted March 3, 1921. It is assumed that the Commission will authorize the issuance of the license at an early date. No delay is anticipated since all the questions involved were threshed out at the time the preliminary permit was granted, in 1921.

Hiawassee River Project—The Southern Appalachian Power Co. has applied for a license for a dam 170 ft. in height, with power house and appurtenant power structures, on Hiawassee River, in Cherokee and Clay Counties, about one mile above Murphy, North Carolina. The installation at the dam will probably be 50,000 hp., and it is planned to dispose of this power by interconnection with existing systems. A few miles of transmission line will connect with the systems of the Georgia Railway & Power Co., Southern Power Co., Alabama Power Co., Tennessee Electric Power Co., and of a number of smaller companies. In addition to developing power at the dam, the large reservoir which will be created by this high dam will completely regulate the flow of the Hiawassee River and will make available this regulated flow through a drop of approximately 375 ft. over a series of five proposed dams below Murphy. It will also increase the power at the Hales Bar plant of the Tennessee Power Co. in Tennessee River and will increase the firm power available at Muscle Shoals by 10 per cent. The reservoir will also have a materially beneficial effect on navigation by increasing the low water flow in Hiawassee and Tennessee Rivers by approximately 13,000 cu. ft. per sec. and by abating the floods of the Hiawassee. The creation of the power dams below Murphy will provide long pools which can be made navigable by the construction of locks. The public has long been demanding that flood waters of our rivers be held back in storage basins for release during the dry season to remove flood menace and increase the navigable capacity of the rivers.

New Publications

Application of Internal-Combustion Engines to Water Works Service. Published by the Worthington Pump and Machinery Corp., 115 Broadway, New York City, 1923. Paper; 6 x 9 in.; 45 pages.

This pamphlet contains reprints from the *Journal of the New England Water Association*, of papers given before the association, June, 1923, as follows: "The Diesel Oil Engine for Water Works Service," by Dr. Charles E. Lucke; "Direct Connection of Diesel Engines and Displacement Pumps," by Rodney D. Hall; "Displacement Pumps Gear Driven by Diesel Engines at Reduced R.P.M." by H. M. Chase; "Centrifugal Pumps for Diesel Engine Drives," by Max Spillman; "Water Works Equipment—Steam vs. Oil Engine," by Rodney M. Hall; discussion incident to the papers.

Large American and German Boilers. By Frederick Muenzinger. Published by Julius Springer, Berlin, Germany, 1923. Paper, 6¼x9⅜ in., 178 pages; 181 illustrations. Printed in German.

This is a comprehensive review and analysis of recent important American boiler installations and their comparison with contemporary German practice. The author acknowledges his indebtedness to leading American engineers, manufacturers, trade catalogs and the technical press. The work is largely descriptive in character, but includes figures, tabulations, curves and other data which would be difficult to obtain without considerable research. The chapter on stokers reveals some interesting German types for burning coking brown coals and contains valuable observations on the performance of both underfeed and chain-grate stokers in central stations. Pulverized coal and its combustion under large boilers, as well as the more recently developed unit equipments for small boilers, are treated at some length. Diagrams to illustrate the shapes, dimensions and volume of representative furnace designs are included. The Milwaukee tests are tabulated in parallel columns with a test conducted on a small German boiler equipped with an A. E. G. Unit Pulverizer and Burner. Following chapters discuss automatic boiler control; the outstanding features of vertical and horizontal water-tube boilers of large capacity; superheaters; economizers; air preheaters; high-pressure boilers; blowers and breechings; boiler settings; accessories and central control panels. Heat balance is briefly described and the recommendation, for more accurate means for weighing the coal supplied to individual boilers during test runs on efficiency, is made. The use of an extensive heat storage system to assist in equalizing boiler and furnace load has not found favor in America up to the present time, but decided progress has been made in Germany with equipment designed for this pur-

pose. Practical examples showing its application in complete formulas for calculating the capacity and expected performance of a system under stated conditions are given. In conclusion the author urges a more intensive study of the combustion of all grades of fuel, heat transmission by radiation and convection, circulation and chemical reactions in the boiler water with respect to their influence on corrosion. The standardization of foundation dimensions of all makes of large boilers of a given rating is suggested to simplify boiler-room designs. Greater cooperation between manufacturers, owners and government or private testing laboratories will lead to noteworthy progress in boiler design.

The Balance of International Payments of the United States in 1922, with a Foreword by Herbert Hoover—Trade Information Bulletin No. 144. Published by the Bureau of Foreign and Domestic Commerce. Government Printing Office. Free.

Anti-Friction Bearings in the Steel Mill. An address delivered by A. M. MacCutcheon, before the Association of Iron and Steel Electrical Engineers, 1921. Published by the Reliance Electric & Engineering Co., Cleveland, Ohio. Paper; 51 pages. Free.

Engineering Kinematics. By William Griswold Smith. Published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Cloth; 6x9 in. 282 pages; 341 illustrations. Price, $3.

Report of Investigations, Department of the Interior, Bureau of Mines. Experiments on Fan-pipe Installations at Butte, Montana, by G. E. McElroy and A. S. Richardson.

The **Final Report** of the **Federal Fuel Distributor** to the President of the United States has been issued recently although dated Sept. 21. It covers the various activities that have been occupying the attention of the Federal Fuel Distributor for the last year concerning the production, distribution and prices of both bituminous and anthracite coal. It contains 29 statistical tables and ten charts. The report can be purchased from the Government Printing Office, Washington, D. C., for 10 cents.

Society Affairs

The Providence Section of the A.I.E.E. will hear Prof. Comfort A. Adams, of the Harvard University School of Engineering, speak on "Electric Welding" on Nov. 22.

The Baltimore Section of the A.S.M.E. has scheduled for Nov. 14, at the Engineers' Club, "Mechanical Engineering Problems of the U. S. Navy," by Rear Admiral Robinson, U. S. N.

The Detroit Sections of the A.S.M.E., A.S.C.E., A.I.E.E. and the Detroit Engineering Society are honoring Dean Mortimer E. Cooley with a banquet to be held at the Hotel Statler on Nov. 23.

The Cincinnati Liberty Association, No. 15, N.A.S.E., will hear D. F. Taylor, of Indianapolis, speak on the Prosser Engine on Nov. 17.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonion Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D C., Jan. 10-11.

American Institute of Chemical Engineers. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Winter meeting at the New Willard Hotel, Washington, D. C., Dec. 5-8.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8.

American Society of Heating & Ventilating Engineers. C. W. Obert, 25 West 39th St., New York City. Annual meeting at New York City, Jan. 22-25.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 3-6.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at Hotel Astor, New York City, Dec. 3-5.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Electric Power Club, S. N. Clarkson, 900 B. F. Keith Bldg., Cleveland. Fall meeting at French Lick Springs Hotel, French Lick, Ind. Nov. 19-22.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Canada. Annual General Meeting at Montreal, Quebec, Jan. 22—Ottawa, Ontario, Jan. 23-24.

Kansas Engineering Society. C. V. Waddington, Kansas Gas & Electric Co., Wichita, Kans. Convention at Wichita, Kans., Dec. 11-13.

National Association of Leather Belting Manufacturers. George H. Blake, P. O. Box 859, City Hall Station, New York City. Annual meeting at Hotel Pennsylvania, New York City, Nov. 21.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 5707 W. Lake St., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Electric Light Association—Southeastern Division. Charles A. Collier, Georgia Railway & Power Co., Atlanta, Ga. Meeting at Hillsboro Hotel, Tampa, Fla., Nov. 19-22.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

The New York Section of the A.I.E.E. will hear papers on "Problems of Electric Drive for Ventilating Equipment of Large Buildings," by C. A. Booth, F. R. Still, C. F. Scott, and J. L. Yardley.

The New Haven Section of the A.S.M.E. will hear about the "S.S. Leviathan, Her Reconditioning and Trial Trip," from Prof. H. L. Seward, of Yale University, who will speak from personal experience. A discussion regarding fuel consumption of various types of ships as well as the "Leviathan" will be held, on Nov. 20.

The Providence Section A.S.M.E. in connection with the Providence Engineering Society will discuss "Fuel Storage" on Nov. 20. Colonel Webb, Fuel Administrator of Rhode Island, will speak and Frederick C. Freemen, Providence Gas Co., will discuss "New England's Future Fuel-Coke." "Oil as a House Heating Fuel" and every phase of the "Empty Coal Bin" will also be discussed.

Obituary

William F. Wendt, founder and former president of the Buffalo Forge Co., of Buffalo, N. Y., and prominent in local and political circles there, died suddenly on Oct. 30. Mr. Wendt was born in Buffalo 65 years ago and was president of the company that he was instrumental in starting, until 1916 when he retired. He has also been president of the George L. Squier Manufacturing Co., the Buffalo Steam Pump Co. and the W. E. Wendt Publishing Co.

Edgar E. Strong, founder and for thirty-six years head of the firm of Strong & Hammond Co., died in Cleveland, Ohio, on Oct. 29. Mr. Strong was born in Manchester, Conn., in April, 1841, and was educated in the district and church schools of Greenwich, Conn. In 1862 he enlisted with the Sixteenth Connecticut Volunteers for the Civil War, fought in the battle of Antietam and was imprisoned for eleven months in Southern prisons. He was first connected in business in Cleveland with W. Bingham Co., where he remained twenty years. Later he was connected with N. G. Browne in a lumber business which met with various disasters, he then associated himself with R. H. Carlisle and W. J. Turney. After a time the firm of Strong, Carlisle & Hammond was formed, of which his son, Herbert W. Strong, is now a member.

Personal Mention

William H. Patchell's many American friends will learn with pleasure that the Council of the British Institute of Mechanical Engineers has decided to nominate him as the president of the Institute for 1924. Such a nomination is equivalent to an election.

Prof. Vladimir Karapetoff, of the Electrical School of Engineering, Cornell University, has been awarded a prize of four thousand francs by the Montefiore Foundation of the University of Liege, Belgium. The award was made for his kinematic computing devices for electrical machinery.

Dean K. Chadbourne, manager of the department of the Far East, of the Westinghouse Electric International Co., has left for a visit in Japan, China, the Philippine Islands, Java, Australia and New Zealand.

Walter R. Roxbury has resigned from the engineering department of the New York Edison Co. to become an engineer in charge of the public-utilities division of power-plant equipment of the McIntire Corp., Newark, N. J.

Francis R. Wadleigh, chief of the coal division of the Bureau of Foreign and Domestic Commerce, and formerly Federal Fuel Distributor, has resigned his position with the government because of the meagerness of the salary.

Clark A. Terry has recently severed his connection with the General Electric Co. as engineer at Schenectady, N. Y., to become superintendent of the Sherman Island Hydro-Electric Development Co., of the International Paper Co., at Glens Falls, N. Y.

David R. Cooper, formerly with the Fargo Engineering Co., Jackson, Mich., and Stone & Webster, of Boston, has recently established an office for the private practice of consulting engineering and the designing of modern hydroelectric power plants, at 515 Dillage Bldg., Syracuse, N. Y.

Business Notes

The McClellan Refrigerating Co. has moved its general offices and works to 1200 West 145th St., East Chicago, Ill.

The Oklahoma Gas & Electric Co. announces that C. B. Owens has resigned as manager of the Shawnee Gas & Electric Co., and that William B. Anthony has been appointed to succeed him.

Pioneer Rubber Mills, manufacturers of piston-rod packing, etc., have moved their general offices to 345-353 Sacramento St., San Francisco, Calif.

Locke Regulator Co., of Salem, Mass., employs a woman Mrs. J. H. Broomhall, of Kansas City to represent it in its southwestern territory. She has proved most successful.

The Orton & Steinbrenner Co., 608 South Dearborn St., Chicago, Ill., manufacturer of locomotive cranes, buckets and coal crushers, has recently completed a large addition to its works that will approximately double the output of the company.

The Celite Products Co., of 53 West Jackson Blvd., Chicago, Ill., has recently instituted the method of distributing engineering data on its heat-insulation products, blueprints and charts in sheets punched and ready for insertion in standard Lefax loose-leaf binders.

The **Kerr Turbine Co.** announces several extensions in its sales organization: Starkweather & Broadhurst, Inc., 79 Milk St., Boston, Mass.; H. R. Hanson, 832 Real Estate Trust Bldg., Philadelphia, Pa.; Mechanical Engineering & Equipment Co., 209 South High St., Columbus, Ohio; Southern States Equipment Co., 712 Canal-Commercial Bldg., New Orleans, La.; L. H. Howland, 606 Howard St., San Francisco, Calif.; Henry C. Ashmead, 824 Brown-Marx Bldg., Birmingham, Ala.

Trade Catalogs

Stokers, Hopper Feed Hand—McClave Brooks Co., Scranton, Pa. Bulletin describing hopper-feed hand stokers for all grades of bituminous and lignite fuels.

Testing Instruments—**C. J. Tagliabue**, 88 Thirty-third St., Brooklyn, N. Y. Catalog 699 "Tag Oil Testing Instruments for Petroleum Products," contains many illustrations and useful tables.

Unaflow Engines—Ames Iron Works, Oswego, N. Y. Bulletin 1924 shows the installations of these engines, a steam consumption chart with the relative economies of prime movers and a picture of the vertical four-cylinder engine. An unusually interesting catalog.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 29, 1923	Nov. 5, 1923
Pool 1,	New York	2.85@3.25	$2.75@3.25
Smokeless,	Columbus	2.00@2.65	2.00@2.65
Clearfield,	Boston	1.50@2.50	1.70@2.40
Somerset,	Boston	1.75@2.75	2.00@3.00
Kanawha,	Columbus	1.75@2.00	1.75@2.00
Hocking,	Columbus	1.75@2.00	1.75@2.00
Pittsburgh No. 8	Cleveland	1.80@1.90	1.80@1.90
Franklin, Ill.	Chicago	2.25@3.00	2.25@3.00
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.50@1.85	1.50@1.85
S. E. Ky.,	Louisville	1.50@2.00	1.50@2.25
Big Seam,	Birmingham	1.75@2.15	1.75@2.15

FUEL OIL

New York—Nov. 8, light oil, tank car lots, 28@34 deg. Baumé, 3¾c. per gal., 36@40 deg. 4c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Oct. 30, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70; 28@30 deg., $1.80; 32@36 deg., gas oil, $1.90; 36@40 deg., distillate, $2.05@2.10 per bbl.

Pittsburgh—Oct. 30, f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5¾c.; 34 deg., neutral 8c. per gal.

Dallas—Nov. 2, f.o.b. local refinery, 26@30 deg., $1.35 per bbl.

Cincinnati—Oct. 30, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6¼c. per gal.

Philadelphia—Nov. 3, 26@28 deg., $1.68@1.722 per bbl.; 16@20 deg., $1.50@1.55; 14@16 deg., $1.45@1.515.

Chicago—Nov. 2, 24@26 deg., $1.72 per bbl.; gas oil, 32@36 deg., $1.92 per bbl.

Boston—Nov. 6, tank car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 6¼c. per gal.

New Plant Construction

PROPOSED WORK

Calif., Long Beach—W. L. Porterfield, 141 Ocean Ave., is having preliminary plans prepared for the construction of a 14 story store and office building on Pine St. and Ocean Ave. Cost will exceed $1,500,000. Milwaukee Bldg. Co., Wright-Callendar Bldg., Los Angeles, Archts.

Conn., Hartford—The Bd. of Contract & Supply, Municipal Bldg., will receive bids until Nov. 15 for the construction of a 3 story high school on Maple Ave. Estimated cost $1,200,000. E. T. Wiley, 75 Pratt St., Hartford, Archt. Equipment detail not reported. Noted Oct. 2.

Ill., Chicago—The Chicago, Indianapolis & Louisville R.R., 608 South Dearborn St., J. H. Liebenthal, Purch. Agt., is in the market for a 300 ft. air compressor.

Ill., Chicago—The Morrison Hotel Co., Madison and Clark Sts., is having new plans prepared for the construction of a 22 story, 67 x 190 ft. hotel, including steam heating system. Estimated cost $2,500,000. Holabird & Roche, 104 South Michigan Ave., Archts.

Ill., Chicago—The Sheridan Trust & Savings Bank, 4738 Broadway, is having plans prepared for the construction of a 12 story bank building, including steam heating system, on Lawrence St. and Broadway. Estimated cost $1,000,000. Marshall & Fox, 721 North Michigan Ave., Archts.

Ill., Chicago—H. E. Wallace, Clk. of the Sanitary Dist. of Chicago, Room 700, 910 South Michigan Ave., will receive bids until Nov. 22 for (A) construction of 1,200 ft. of concrete sewers; (B) substructure of 95th St. sewage pumping station, including pumping, iron castings, sluice gates, etc.; (C) pumping station superstructure; (D) furnishing three 72 in. and three 30 in. centrifugal pumps with equipment; (E) three 500 hp. and three 75 hp. synchronous motors, six 667 kva. and six 75 kva. transformers, two 75 kw. motor generator sets and equipment; (F) furnishing and installing switchboard, bus bars, 7 kw. battery charging set, storage battery, conduit, wiring, oil circuit breakers, etc.; (G) erection of equipment listed under (D) and all heavy equipment listed under (E), also furnishing and installing auxiliary equipment, piping, etc.

Ill., Columbia—The city is having preliminary plans prepared for a waterworks system, including pumping equipment, tower, tank and distribution system. Estimated cost $50,000. W. A. Fuller Co., 1917 Ry. Exch. Bldg., St. Louis, Mo., Engrs.

Ill., Moweaqua—The city is having preliminary plans prepared for an oil engine lighting plant, generators, switchboard, transmission lines, etc. Estimated cost $75,000. Holbrook, Greeley & Hanson, Decatur, Engrs.

Ill., Trenton — The city is having preliminary plans prepared for waterworks improvements, including steel tower, tank, pumping equipment, new distribution mains, etc. Estimated cost $50,000. W. A. Fuller Co., 1917 Ry. Exch. Bldg., St. Louis, Mo., Engrs.

Ind., Indianapolis—The Indianapolis Light & Heat Co., 48 Monument Pl., C. C. Perry, Pres., plans to build a power plant on the White River, near here. Estimated cost $5,000,000. Engineer or architect not selected.

Ky., St. Matthews—The Masonic Lodge, 2nd and B Sts., Louisville, is having plans prepared for the construction of a Masonic Home for Widows and Orphans, including an office and chapel building, on Shelbyville Rd., here. Estimated cost $1,600,000. Joseph & Joseph, Francis Bldg., Louisville, Archts. Equipment detail not reported. Noted Apr. 3.

La., Crowley—The city will receive bids until Nov. 16 for the construction of sewers, watermain extensions, steel or concrete reservoir and pumps. Estimated cost $200,000. M. Mernard, Engr.

La., Welsh—The city is in the market for a 250 hp. high speed engine for electric light plant. J. T. Smith, Engr.

Md., Baltimore—The Bd. of Awards will receive bids until Nov. 14 for furnishing two 60 hp. motors and two centrifugal pumps for the Highway Engineer Dept. Estimated cost $15,000. B. L. Crozier, City Hall, Engr,

Md., Baltimore—The Emerson Hotel, W. H. Parker, Mgr., plans to build a 17 story, 50 x 150 ft. addition to hotel on Calvert and Baltimore Sts. Estimated cost $1,250,000. Engineer or architect not selected.

Mich., Flint—The County Bldg. Com., H. Haas, Thetford, Chn., is having plans prepared for the construction of a 4 story, 75 x 170 ft. court house and jail, including steam heating equipment, on Saginaw St., here. Estimated cost $1,000,000. F. D. Madison, 209 1st Bank, Royal Oak (Detroit P. O.), Archt.

Miss., Jackson — The Morris Ice Co., Pearl St., plans to rebuild its ice plant, which was destroyed by fire. Estimated cost $175,000. Engineer or architect not selected.

Mo., Hannibal—The city will hold an election Nov. 20 to vote $400,000 bonds for pumps, motors, mains, filtration plant, etc. D. H. Maury, 304 South Dearborn St., Engr. Noted Aug. 28.

Mo., St. Joseph—The city will hold an election Dec. 11 to vote $3,000,000 bonds for the construction of schools and additions to school buildings.

Mo., St. Louis—The Bd. Educ., 911 Locust St., will receive bids until Dec. 5 for the construction of a 3 story, 307 x 375 ft. high school, including heating and ventilating system, air washer, ozone apparatus, vacuum cleaning system, switchboard, engine generators, etc., on Natural Bridge and Vandeventer Sts. Estimated cost $1,500,000. R. M. Milligan, c/o Bd. Educ., Engr. and Archt.

Mo., St. Louis—The Knights of Columbus, 3549 Olive St., plans to build a 10 story, 150 x 290 ft. club and office building, including auditorium, seating capacity 2,000, on Lindell Blvd. and Sarah St. Estimated cost $1,250,000. Engineer or architect not selected.

Mont., Billings—The Badger Showcase Co., 133 North Pearl St., plans to build a 2 story, 60 x 160 ft. factory and a 35 x 40 ft. boiler house on South Broadway. Estimated cost $60,000.

Neb., Crete—The Council, C. E. Beals, Clk., plans to build an electric light and power plant.

N. Y., Albany—H. Goodman, Eagle and Howard Sts., is having plans prepared for the construction of an 8 story, 65 x 100 ft. store and office building on South Pearl St. Estimated cost $1,000,000. Private plans. Equipment detail not reported.

N. Y., Jamestown—The city received bids for equipment and installation of a turbine generator from the Ridgway Eng. Co., Ridgway, Pa., $69,987; Genl. Electric Co., River Rd., Schenectady, $77,820; Allis-Chalmers Co., South Milwaukee, Wis., $79,180. Noted Oct. 23.

N. Y., New York—The Bd. Educ., 500 Park Ave., is having plans prepared for the construction of P. S. 99 on Exterior Sts.; a training school on West 135th St. between Convent and St. Nicholas Aves.; 5 story, 175 x 200 ft. P. S. 173 on Fort Washington Ave. and 173rd St., including steam heating systems. Estimated cost $1,500,000, $1,500,000 and $1,000,000 respectively. W. H. Gompert, Flatbush Ave. Extension and Concord St., Brooklyn, Engr. and Archt.

N. Y., New York—The Marlboro Realty Corp., c/o G. and E. Blum, Archts., 505 5th Ave., is having plans prepared for the construction of a 20 story office building at 1351 Broadway. Estimated cost $2,750,000. Equipment detail not reported.

N. Y., New York — The One Thousand Forty Park Ave. Corp., c/o Delano & Aldrich, Engrs. and Archts., 126 East 38th St., is having plans prepared for the construction of a 14 story, 100 x 123 ft. apartment house at 1040 Park Ave. Estimated cost $1,500,000. Equipment detail not reported.

N. Y., New York—The Seventh Ave. & 35th St. Corp., c/o Buchman & Kahn, Engrs. and Archts., 56 West 45th St., is having plans prepared for the construction of a 22 story office building on 7th Ave. and 35th St. Equipment detail not reported.

N. Y., Rochester—The Homeopathic Hospital, 224 Alexander St., plans to build an addition to its hospital. Estimated cost $400,000. Engineer or architect not announced.

N. C., Rocky Mount — A committee appointed by the Mayor and Bd. of Aldermen has retained W. C. Olsen, Engr., Kinston, to make a report on and prepare plans and specifications for remodeling and enlarging waterworks and power plant. Noted Oct. 23.

Ohio, Cleveland—The Lakeside Hospital, S. Mather Endowment, East 12th St. and Lakeside Ave., is having plans prepared for the construction of an 8 story nurses' home, including steam heating system, on Euclid Ave. and Adelbert Rd. Estimated cost $1,000,000. Coolidge & Shattuck, 122 Ames Bldg., Boston, Archts.

Ohio, Dayton—The Third Natl. Bank, 21 East 3rd St., C. J. Moore, Pres., has had plans prepared and will receive bids until Nov. 20 for the construction of a 4 story, 120 x 187 ft. bank and office building on Main St. Estimated cost $1,500,000. Schenck & Williams, Mutual Home Bldg., Dayton, Archts. Equipment detail not reported.

Okla., Canton—The town voted $30,000 bonds and will receive bids about Dec. 15 for a waterworks system, including construction of well, 50,000 gal. tank, tower, pumphouse; installation of triplex pump and engine; also distribution system. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs. Noted Nov. 21, 1922.

Pa., Phila. — F. H. Caven, Dir. Public Wks., and the Bd. of Trustees, Room 216 City Hall, will receive bids until Nov. 21 for installation of heating and ventilating systems, also refrigerating and vacuum cleaning plants, etc., in building of the Free Library.

Pa., Phila.—The Phila. & Reading Ry., Reading Terminal, Phila., plans to expend about $1,600,000 for new machinery, additional piers and other ore handling equipment, at Port Richmond. This will include the installation of another set of ore handling machinery and enlarging of pier 14, $915,000. Extensive work will also be done on the boiler house, including the installation of a 1,000 hp. boiler, $915,000. S. T. Wagner, Ch. Engr.

Pa., Rook (Pittsburgh P. O.)—The Pittsburgh & West Virginia Ry., Wabash Bldg., Pittsburgh, is receiving bids for the construction of a 1 and 2 story, 47 x 99 ft. power and boiler house, here. Crecilius & Phillips, Hanna Bldg., Cleveland, Ohio, Archts.

S. C., Summerville—The city, Commissioner of Public Wks., is in the market for one 250 hp. and two 150 hp. return tubular boilers.

Tenn., Jackson—The city plans to issue $100,000 bonds for extensions and improvements to water plant, including new reservoir, pumps, pipe lines, etc.

Tex., Corsicana—G. A. McGregor, Kirby Bldg., is having plans prepared for the construction of a 5 story, 65 x 80 ft. hotel on 11th and 4th Sts. Estimated cost $300,000. Young & Young, S. W. Life Bldg., Dallas, Archts. Equipment detail not reported.

Tex., Dallas—The B. E. Keith Co., 2018 Cadiz St., has had plans prepared for the construction of a 3 story, 90 x 105 ft. warehouse and cold storage plant on Preston and Cadiz Sts. Estimated cost $175,000. C. A. Moore, Minneapolis, Minn., Engr. Noted July 10.

Tex., Elgin—The Elgin Light & Power Co. has had plans prepared and will soon receive bids for the construction of a power plant. Estimated cost $50,000. Private plans. The owner will purchase motors and ice machine.

W. Va., Keyser—The city, E. V. Romig, Mayor, office of City Clerk, will receive bids until Dec. 12 for the construction of a 2,000,000 gal. rapid sand filtration plant, steel reservoir tank, elevated tank, booster pumping station, c.i. pipes, force mains, centrifugal pumps, etc. J. N. Chester Co., Union Bank Bldg., Pittsburgh, Pa., Engrs. Noted Oct. 23.

Wis., Genoa Junction—The village, T. E. Watson, Clk., will receive bids until Nov. 16 for the construction of a pumping station and reservoir. W. G. Kirchoffer, Vroman Bldg., Madison, Engr. Noted June 19.

N. S., Stewiache—The town is in the market for electric light plant equipment.

Ont., Arnprior—The town, M. Campbell, Chn., Waterworks Com., is in the market for additional machinery for pump house.

Ont., Ottawa—The Ottawa Electric Ry., 248 Albert St., F. D. Burpee, Supt., is in the market for a Westinghouse 200 kva. rotary converter and three 800 kva. self cooled transformers.

Ont., Saulte Ste. Marie—The Dominion Hotels, Ltd., 66 King St., Hamilton, is having plans prepared for the construction of a 3 or 4 story hotel to contain 100 to 150 rooms, including steam heating system, here. Estimated cost $300,000. V. K. Gibson, 624 South Michigan Ave., Chicago, Ill., Archt.

Ont., Welland—The town is having a report prepared for water supply improvements and extensions, including c.i. pipe, valves, hydrants, electric centrifugal umps, etc. Estimated cost $30,000. Chipman & Power, Mail Bldg., Toronto, Engrs.

Ont., Wiarton—The Council, A. Gilpin, Mayor, has requested the Hydro Power Comn. to furnish estimates of developing electrical power from the Sauble River.

Que., Ile aux Chats (Valleyfield P. O.)—The Pure Ice Co., Ltd., is in the market for a complete plant for the manufacture of ice.

CONTRACTS AWARDED

Ala., Fairfield — The Rushton Corp. awarded the contract for the construction of a 2 story, 130 x 300 ft. ice factory on Crawford St. to Holly & Davis, Fairfield. Estimated cost $150,000. The owner is in the market for ice making machines.

Ark., Hot Springs—The Arlington Hotel Co., Central Ave., awarded the general contract for the construction of an 11 story, 200 x 200 ft. hotel to Ault & Burden, Little Rock. Estimated cost $2,100,000. Equipment detail not reported. Noted Oct. 2.

Calif., San Francisco—The Office of the United States Engineer, 85 2nd St., awarded the contract for furnishing booster pump and spare parts to the Maine Iron Wks., 16th and Daggett Sts., San Francisco, $9,685. Noted Nov. 6.

Fla., Crescent City—The city awarded the contract for the construction of a reservoir to E. G. Ladd, 214 Bisbee Bldg., Jacksonville, $1,250; two 700 g.p.m. centrifugal pumps to Fairbanks, Morse & Co., 630 West Bay St., Jacksonville, $26,250. Noted Sept. 4.

Ky., Pond Creek (Drakesboro P. O.)—The Illinois Central R.R., 135 East 11th Pl., Chicago, awarded the contract for the construction of a pumping station, elevated steel water tank, etc., here, to J. E. Nelson & Sons, 3240 South Michigan Ave., Chicago. Cost will exceed $40,000.

N. J., Morsemere—Barclay & Co. awarded the contract for the construction of an additional unit to plant, consisting of a power house, to the J. W. Ferguson Co., 253 Broadway, New York.

N. C., Andrews—The town, P. B. Ferebee, Mayor, awarded the contract for the construction of a dam, power house and an 11 mi. transmission line to Tucker & Laxton, Realty Bldg., Charlotte, $230,000; equipment to the Genl. Electric Co., 120 Broadway, New York, $50,000; water wheels to the S. M. Smith Co., York, Pa., $20,000. The plant will develop about 1,500 hp. Noted Oct. 9.

N. C., Wilmington—The Cape Fear Hotel Co. awarded the contract for the construction of a 10 story hotel on 2nd and Chestnut Sts. to W. Clark, Wilmington. Estimated cost $800,000. Equipment detail not reported. Noted Oct. 30.

Ohio, Portsmouth—A. Hurth, Jr., representing the Hurth Hotel Co., awarded the contract for the construction of an 8 story, 40 x 110 ft. hotel on Chillicothe and 3rd Sts. to Taylor & Linn, 5th and Main Sts., Zanesville. Estimated cost $300,000. Equipment detail not reported. Noted May 8.

Ore., Portland—The Triangle Milling Co. awarded the contract for the construction of a 1 story, 75 x 116 ft. mill building and a 3 story, 32 x 36 ft. storehouse on Tillamook St. between Larrabee and Kirke Sts., to C. W. Ertz, Pillock Bldg., Portland. Estimated cost $20,000. The owner is in the market for an 80 hp. boiler, 60 hp. engine, conveying machinery, etc.

Pa., Pittsburgh—The Bd. Educ., Fulton Bldg., awarded the contract for the construction of a 4 story addition to high school on Ruth St. to A. & S. Wilson, 541 3rd Ave., $756,735. Total estimated cost $1,000,000. Equipment detail not reported. Noted Oct. 16.

Tex., Houston—The Houston Power & Light Co., Capitol and San Jacinto Sts., awarded the contract for the construction of an addition to its power plant on Gable St. to D. Hall, Carter Bldg., Houston. Estimated cost $60,000.

Va., Roanoke—The Roanoke Ice & Cold Storage Co. is building a 100 x 130 ft. addition to its ice plant and will install equipment.

Wis., Beloit—E. R. Branigan, 298 Eclipse Ave., awarded the contract for the construction of a 2 story, 40 x 80 ft. ice plant to Petitt & Howard, 140 Argill Ave., Beloit. Estimated cost $40,000. The owner is in the market for ice making machinery.

Ont., Toronto—Chapmans, Ltd., 330 Gerard St., E., awarded the contract for an addition to ice plant to Witchall & Son, 156 St. Helens Ave., Toronto. Estimated cost $75,000. The owner will purchase ice manufacturing machinery and equipment.

Que., Drummondville—The Southern Canada Power Co., Ltd., 20 St. Nicholas St., Montreal, awarded the contract for the construction of a 30,000 hp. power house at Hemming Falls, here, to the Foundation Co., 120 liberty St., New York. Noted Sept. 4.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Declines—Rubber covered copper wire lower in New York. Clay brick down $2 and silica brick $3 per M. during month. Crude chrome ore also lower. Portland cement, $2.55@$2.65 per bbl., without bags, delivered in New York, against $2.70 @$2.80 one month ago. Reduction in structural rivets at Pittsburgh mill; smaller sizes also lower in Cleveland warehouses. Wiping cloths down ¾c. per lb. in New York. Decline in rawhide lacing during month; leather belting, however, shows decided upward trend.

Advances—Raw linseed oil, 98c. f.o.b. New York, against 95c. per gal. (5 bbl. lots) one month ago. Babbitt metal up 1 to 2c. per lb. in Chicago. No other advances reported.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled	51½c. per ft.
Common, 2½-in., 3-ply	$1.00 per ft. list less 40-10-5%

Air—Best grade

¾-in., per ft.	3-ply $0.33	4 ply $0.42

Steam—Discounts from List

First grade 40-5%	Second grade 45%	Third grade 50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	60-5%	Best grade	50-10-5%

LEATHER BELTING—List price, 2c. per sq. in., per ply.

Grade	Discount from list
Medium	30-10%
Heavy	20-5-2½%

RAWHIDE LACING—For cut, best grade, 45-5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45-5%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in	$0.90
Asbestos for high-pressure steam, ⅛ in	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	74%
	3-ply	76%
	2-ply	78%

PORTLAND CEMENT—New York, $2.55@ $2.65 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.64 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	10.00@13.00	15.00	11.00
Colored	8.00@13.00	12.00	8.00

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	10.00	13.00
New York	10.25	.....
Cleveland	$36.00 per M.	$52.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.98	$1.05	$1.14

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	14.00	12.75	15.50	14.25
White	14.00	12.75	14.00	12.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅛ and smaller	50-10%	60%	60%
Tinned	50-10%	60%	4½c. per lb. net

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York	$4.40	Chicago	$3.75	Pittsburgh	$2.75@3.00

Boiler rivets, same sizes:

New York	$4.50	Chicago	$3.85	Pittsburgh	$3.10@3.35

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$50@55
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	26@31
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	30@35
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	42.00@43.50
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@50
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	42@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	42@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvana	per M	38@45
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	37@39
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	37@39
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	52.00	52.00	42@45
(35% tin)	25.00	17.50	18@22

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.65	$3.90	$4.55
Flats, square and hexagons, per 100 lb. base	5.15	4.40	5.05

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	¼ to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½ to 4	26	11
7 and 8	56	43½	4½ to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	¼ to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	32	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
4	.....	.....	$0.23
1½	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
1	.20	.25	.21
1¼	.23	.29	.23
1½	.24	.33	.28
2¼	.....	.....	.....
2	.30	.41	.32
2½	.32	.47	.35
3¼	.34	.51	.37
2	.43	.64	.47

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2¼ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3¼ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 46.00 (net)	$ 81.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	30%	15%
Coils to 1,000 ft.	40%	20%
1,000 to 5,000 ft.	45%	25%
5,000 ft. and over	45–5%	25–5%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$61.10	$66.16	$9.90	$11.03	$5.74	$6.16
¾	79.20	84.95	13.00	14.49	8.18	8.78
1	112.06	122.19	19.26	21.46	10.65	11.42
1¼	151.62	165.31	25.65	28.33	14.76	15.78
1½	181.28	197.67	34.19	37.77	18.23	19.47
2	248.90	265.94	62.70	69.24	24.29	25.97
2½	385.50	420.48	102.58	11.33	34.71	37.10
3	504.29	548.81	273.40	302.12	51.66	55.63
3½	633.86	688.65	604.03	667.15	69.41	74.19
4	772.62	838.59	697.06	770.99	86.76	92.73

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.10	D. P. D. B.	$0.32
D. P. M. L.	.16	T. P. S. B.	.30
T. P. M. L.	.24	T. P. D. B.	.42
D. P. S. B.	.18		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.75	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.90	....
T. P. S. B.	.65	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.15	3.00	.....
T. P. to D. P. D. B.	.80	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	29.00
No. 18 cotton reinforced light	19.50
No. 16 cotton reinforced light	22.50
No. 18 cotton Canvasite cord	17.00
No. 16 cotton Canvasite cord	19.25

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.20	3-amp. to 30-amp.	100	$0.40
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22½%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.70
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.32	$0.37	120	75	$0.55	$0.60	60
15	.32	.37	120	100	.70	.75	24
25	.32	.37	120	150	.90	.95	24
40	.32	.37	120	200	1.15	1.25	24
50	.32	.37	120	300	1.75	1.85	24
60	.37	.42	120				
				500	2.50	2.65	12
				750	3.75	4.00	8
				1,000	4.25	4.50	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.19
Composition 2-piece attachment plug	.29
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.80	$ 9.27	$10.75	$17.20
12	9.50	11.79	13.40	23.40
10	12.70	15.50	17.20	29.00
8	17.50	19.80	22.87	38.00
6	.....	.....	32.00	.....
4	.....	.....	43.75	.....
2	.....	.....	64.00	.....
1	.....	.....	85.50	.....
0	.....	.....	109.00	.....
00	.....	.....	132.00	.....
000	.....	.....	159.00	.....
0000	.....	.....	189.00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	¾ In. Cap — Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32½%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N E.C

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%